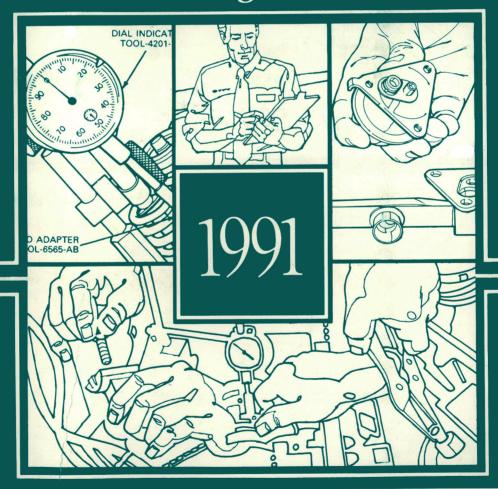
# BRONCO, ECONOLINE, F-SERIES, F-SUPER DUTY

### TRUCK SHOP MANUAL

Volume 2 of 2 Engine



## **Table Of Contents**

| Subject          | Group No. |
|------------------|-----------|
| Complete Vehicle | 00        |
| Engine           |           |
| Exhaust System   |           |
| Fuel System      |           |

### **IMPORTANT SAFETY NOTICE**

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Shop Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

### **NOTES, CAUTIONS, AND WARNINGS**

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle with the vehicle jacked up.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific operation. Place wood blocks (4" x 4" or larger) to the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from the moving parts, when the engine is running, especially the fan and drive belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.
- Disconnect the negative battery ground cable before using any electric welding equipment.

### foreword . . .

This 1991 Truck Shop Manual has been prepared to provide information covering normal Engine and related systems service repairs and maintenance for the 1991 Bronco, Econoline (E-150 through E-350), F-150 through F-350 Series and F-Super Duty Ford Trucks manufactured in North America. Refer to the 1991 Engine/Emissions Diagnosis Manual for additional engine and emissions diagnosis information.

Body, Chassis, Electrical, and Pre-Delivery service repairs are covered in the 1991 Light Truck Body, Chassis and Electrical Shop Manual and the 1991 Truck Pre-Delivery Shop Manual.

This manual is divided into Groups covering a general system. The basic part number for components covered in the Group is also included in parenthesis after the Group number. For example:

Engine Group 03 (8000)

General System Covered in Group

Group Number Basic Part Number for Cooling System Components

Some components covered within a Group do not have the same basic part number. In these cases, more than one basic part number will appear on the Group index. For example:

General System
Covered in Group

Basic Part
Number for
Gasoline
Engine
Components

Basic Part
Number Only

Within each Group, the information is further divided into smaller Sections. There is one Section for each component in the system, as well as a General Service Section in some Groups to cover procedures common to several Sections within the Group. In general, each Section contains the Description, Operation, Diagnosis and Testing, Removal and Installation and Disassembly and Assembly procedures for the component covered in the Section. Diagnosis Charts are also included in some Sections to help you systematically locate the correct problems encountered. In most cases, specifications are included at the end of each Section.

To aid in locating specific items in this manual, use the Alphabetical Subject Index in the back of the manual, or the Group and Section Index on the following pages.

As a further aid, there is an index on the first page of each Group listing the Section title and Basic Part number for components covered within the Group. The first page of each Section contains an index to locate service operations covered in that Section. This Group-Section breakdown is also indicated in the page number located at the top of each page.

Example: 03-01-10 = (Group) 03 — (Section) 01 — (Page) 10

The descriptions, testing procedures, and specifications in this manual were in effect at the time the manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design or testing procedures without notice and without incurring obligation. Any reference to brand names in this manual is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents if available may be used. The right is reserved to make changes at any time without notice.



Ford Parts and Service Division Service Publications

### **GROUP**

# COMPLETE VEHICLE OO

| SECTION TITLE PAGE          | SECTION TITLE PAGE                 |
|-----------------------------|------------------------------------|
| IDENTIFICATION CODES00-01-1 | MAINTENANCE AND LUBRICATION00-03-1 |

### **SECTION 00-01 Identification Codes**

| SUBJECT                                 | PAGE    | SUBJECT                             | PAGE             |
|---|---------|-------------------------------------|------------------|
| GENERAL INFORMATION                     |         | VEHICLE APPLICATION                 | <b>00-0 1-</b> 1 |
| Build Date Stamp Locations              | 00-01-5 | VEHICLE IDENTIFICATION NUMBER (VIN) |                  |
| Vehicle Data                            | 00-01-5 | Codes                               | 00-01-6          |
| Vehicle Identification Number (VIN)     | 00-01-4 |                                     |                  |
| Vehicle Safety Compliance Certification |         |                                     |                  |
| Label                                   | 00-01-1 |                                     |                  |
|   |         |                                     |                  |

### **VEHICLE APPLICATION**

E-150 Through E-350, F-150 Through F-350, F-Super Duty Series, and Bronco Vehicles

### **GENERAL INFORMATION**

### **Vehicle Safety Compliance Certification Label**

The English Safety Compliance Certification Label is attached to the drivers door lock pillar. The French Safety Compliance Certification Label is attached to the door latch edge on the passenger's side door. The label contains the name of the manufacturer, the month and year of manufacture, the certification statement, and the Vehicle Identification Number. The label also contains Gross Vehicle Weight Ratings, Wheel and Tire data, and information codes for additional vehicle data.

### SAFETY COMPLIANCE CERTIFICATION LABELS **COMPLETE VEHICLES**

### (UNITED STATES)

#### MFD. BY FORD MOTOR CO. IN U.S.A. **DATE: 2/91** GVWR: 4900 LB/2222 KG FRONT GAWR: 2684 LB REAR GAWR: 3750 LB WITH 1217 KG 1700 KG WITH P195/75R15SL TIRES P195/75R15SL TIRES 15x6.0 JK RIMS 15x6.0 JK RIMS AT 35 PSI COLD AT 35 PSI COLD THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE VIN: 1FTBF15G5 KMA00000 TYPE: WB TYPE GVW BODY TRANS AXLE TAPE SPRING

### (CANADA)

|       | MFD. BY FORD MOTOR   | R CO. | OF CAN   | IADA LTD.     |
|-------|--|-------|----------|---------------|
| DATE: | GVWR:  |       |          |               |
| FRONT | GAWR:  | REAR  | GAWR:    |               |
|       | WITH   |       |          | WITH          |
| l     | TIRES  |       |          | TIRES         |
|       | RIMS   |       |          | RIMS          |
| AT    | PSI COLD   | AT    | PSI COLI | D             |
|       | /ehicle conforms to all appli<br>andards in effect on the dat<br>: |       |          |               |
|       |  |       |          |               |
| EXTER | RIOR PAINT COLORS  | _     |          | DSO           |
| WB    | TYPE GVW BODY T  | RANS  | AXL      | E TAPE SPRING |
| 1     | MADE IN  | CANA  | ADA      |               |

### (QUEBEC)

| FABR. AUX E        | -U PAR LA FORD MOTOR CO.   |
|--------------------|--|
| DATE: PNB          | V:   |
| PNBE AV:           | PNBE AR:   |
|                    | AVEC   |
|                    | <pneus►< th=""></pneus►<>  |
|                    | «JANTES»   |
| A LB/PO' A FROID   | A LB/PO <sup>2</sup> A FROID   |
| des v.a. en viguel | ne a toutes les normes federales de securite<br>ur a la date de fabr. Iniquee ci-dessus. |
| NIV:<br>TYPE:      |  |
|                    |  |
| COULEUR            | N° COMM SPEC.  |
| EMPATT. TYPE/PBV   | CARR TRANSM. PONT BANDE RESSORT  |
|                    |  |

(QUEBEC)

| DATE: PNBV:                 |              |  |
|-----------------------------|--------------|--|
| PNBE AVANT:                 | PNE          | BE ARRIERE:  |
| THUS NOTHING                | AVEC         | DE ATTITUETTE.   |
|                             | 4PNEUS Þ     | _  |
|                             | 4PHEUSP      |  |
| A LB/PO' A FROID            | A            | LB/PO* A FROID   |
|                             |              | NORMES FEDERALES DE SECURITE<br>FABR. INIQUEE CI-DESSUS. |
|                             |              |  |
| DES V.A. EN VIGUEUR<br>NIV: | A LA DATE DE | FABR. MIQUEE CI-DESSUS.                                  |

FOR VEHICLES MFD IN U.S.A. FOR QUEBEC, CANADA

FOR VEHICLES MFD. IN CANADA FOR QUEBEC, CANADA

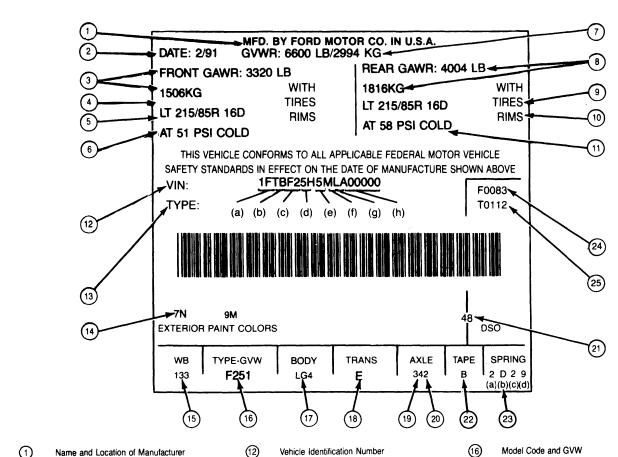
### **INCOMPLETE VEHICLES**

THE INCOMPLETE VEHICLE RATING DECAL IS INSTALLED ON THE DRIVER'S DOOR LOCK PILLAR IN PLACE OF THE SAFETY COMPLIANCE CERTIFICATION LABEL.



| INCOMPLETE VEHICLE MANUFACTURED BY |  |                  |       |      |      |             |  |  |  |
|------------------------------------|--|------------------|-------|------|------|-------------|--|--|--|
|                                    | GVWR: 3020 LB/1369 KG VEHICLE IDENTIFICATION NUMBER 1FTBF25G5 KLA00000 |                  |       |      |      |             |  |  |  |
| EXTERIO                            | OR PAINT COLO  | <sub>RS</sub> 51 |       |      | 48   | DSO         |  |  |  |
| WB                                 | TYPE GVW   | BODY             | TRANS | AXLE | TAPE | SPRING 2D29 |  |  |  |
| 133                                | 133 F270 AB4 F 38 B 1991   |                  |       |      |      |             |  |  |  |
|                                    |  |                  |       |      |      |             |  |  |  |

CY2666-J



- (1) Name and Location of Manufacturer
- (2) Date of Manufacture
- ③ Front Gross Axle Weight Ratings in Pounds (LB) and Kilograms (KG)
- 4 Front Tire Size
- (3) Rim Size
- **6** Front Tire Cold PSI
- 7 Gross Vehicle Weight Rating in Pounds (LB) and Kilograms (KG)
- (8) Rear Gross Axle Weight Rating in Pounds (LB) and Kilograms (KG)
- (9) Rear Tire Size
- **(10)** Rim Size
- 11) Rear Tire Cold PSI

- (12) Vehicle Identification Number
  - (a) World Manufacturer Identifier
  - Brake System and Gross Vehicle Weight Rating (GVWR) Class for Ford completed Trucks and MPV's. For Buses and Incomplete Vehicles, the fourth digit determines the brake system (only).
  - (c) Model or Line, Series, Chassis, Cab or Body Type
  - Engine Type
  - Check Digit
  - Model Year (Ford-Complete Trucks and MPV's)
  - Assembly Plant Code
  - (h) Sequence Number
- (13)Type Vehicle
- (14) Exterior Paint Codes (two sets of figures designates a two-tone)
- (15) Wheelbase in Inches

- Model Code and GVW
  - Interior Trim, Seat and Body/Cab Type
- 18) Transmission Code

17)

- (19) Rear Axle Code
  - Front Axle Code if so Equipped
- 20) 21) District/Special Order Codes
- 22) External Body Tape Stripe Code
- 23) Suspension Identification Codes (a) Aux./Opt. Usage Code (Front)
  - (b) Front Spring Code
  - Aux./Opt. Usage Code (Rear)
  - (d) Rear Spring Code
- Front Axle Accessory Reserve Capacity in 24)
- 25) Total Accessory Reserve Capacity in Pounds

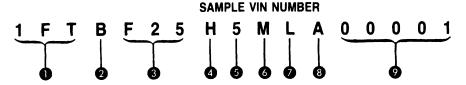
CW1017-Y

### **Vehicle Identification Number (VIN)**

A seventeen digit combination of numbers and letters forms the Vehicle Identification Number (VIN). The VIN is stamped on a metal tab that is riveted to the instrument panel close to the windshield. The VIN number is viewable by looking through the front windshield on the driver's side. The VIN number is also found on the Safety Compliance Certification Label.

By looking at the seventeen digit VIN number a variety of information about the vehicle can be determined. The first three digits identify the manufacturer and the vehicle make and type. The fourth digit determines the Gross Vehicle Weight Rating (GVWR-Class) and Brake System for Ford completed Trucks and MPV's. For Buses and incompleted vehicles, the fourth digit determines the brake system (only). Digits five, six and seven identify the model or line, series, chassis, and cab or body type. The eighth digit points out the particular engine found in the vehicle. Digit nine is the VIN check digit. The tenth digit identifies the model year of a Ford-completed vehicle, or the model year of the incomplete vehicle, if sold by Ford as an incomplete vehicle. The eleventh digit determines the assembly plant. Digits twelve through seventeen make up the sequence serial and warranty number. Digit twelve uses the letter "A" until the production or sequence of 99,999 units (digits thirteen through seventeen) is reached. Letter "A" then becomes "B" for the next production sequence of vehicles.

Refer to the following illustrations to help in further explanation of the Vehicle Identification Number (VIN).



- Position 1, 2 and 3 Manufacturer, Make and Type (World Manufacturer Identifier)
- Position 4 Brakes System/GVWR Class for Fordcompleted Trucks and MPV's. For Buses and Incomplete Vehicles, Brake System (only).
- Position 5, 6 and 7 Model or Line, Series, Chassis, Cab or Body Type
- Position 8 Engine Type
- Position 9 Check Digit

- O Position 10 Model Year (Ford-completed vehicles)
- Position 11 Assembly Plant
- Position 12 Constant "A" until sequence number of 99,999 is reached, then changes to a constant "B" and so on
- Position 13 through 17 Sequence number begins at 00001

CY2376-K

### **VEHICLE IDENTIFICATION NUMBER (VIN) CODES**

WORLD MANUFACTURER IDENTIFIER (VIN POSITIONS 1, 2 AND 3)

1FT BF25H5 M LA00001

| VIN Code | Manufacturer                       | Make | Туре   |
|----------|------------------------------------|------|--|
| 1FM      | Ford Motor Company, USA            | Ford | Multi-Purpose Passenger Vehicle (MPV)                      |
| 1FT      | Ford Motor Company, USA            | Ford | Truck (Complete Vehicle)                                   |
| 1FD      | Ford Motor Company, USA            | Ford | Incomplete Vehicle (IV)                                    |
| 1FC      | Ford Motor Company, USA            | Ford | Basic (Stripped) Chassis                                   |
| 1FB      | Ford Motor Company, USA            | Ford | Bus  |
| 1FF      | Ford Motor Company, USA            | Ford | Motor Vehicle Equipment without Engine/Powertrain (Glider) |
| 2FM      | Ford Motor Company of Canada, Ltd. | Ford | MPV  |
| 2FT      | Ford Motor Company of Canada, Ltd. | Ford | Truck (Complete Vehicle)                                   |
| 2FD      | Ford Motor Company of Canada, Ltd. | Ford | Incomplete Vehicle   |
| 2FC      | Ford Motor Company of Canada, Ltd. | Ford | Basic (Stripped) Chassis                                   |
| 2FB      | Ford Motor Company of Canada, Ltd. | Ford | Bus  |
| 2FF      | Ford Motor Company of Canada, Ltd. | Ford | Motor Vehicle Equipment without Engine/Powertrain (Glider) |
| 3FC      | Ford Motor Company of Mexico       | Ford | Basic (Stripped) Chassis                                   |

CY2377-K

Refer to the code definition portion of this Section for specific definitions of the numbers and letters of the Vehicle Identification Number (VIN).

#### **Build Date Stamp Locations**

The vehicle build date stamp is located as follows: On Bronco and Light Trucks (F-150—F-250—F-350) the vehicle build date is stamped on the front surface of the radiator support on the passengers side of the vehicle. On Econoline vehicles (E-150 — E-250 — E-350), the build date is stamped on top of the radiator support. Following is a sample of the four digit number that indicates the month and day of build.

Actual Date of Build Date Stamp on Vehicle January 24 0124

October 21 1021

Yellow ink is used for the date stamp. When the marking surface is painted the body color, the date stamp will be marked in red ink. Units from the Ontario Truck Plant (Code C) will be marked with silver ink.

#### **Vehicle Data**

The Vehicle Data appears on the Safety Compliance Certification Label on the second and third lines following the identification number. The code set (two numbers, or a number and letter) above COLOR identify the exterior paint color (two sets of codes designate a two-tone). The three digits under W.B. designate the wheelbase in inches. The letter and three digits under TYPE / G.V.W.R. designate the truck model within a series and the gross vehicle weight rating. The letters and/or numeral under BODY designate the interior trim, seat and body type. The transmission installed in the vehicle is identified under TRANS by an alphabetical code. A letter and a number or two numbers under AXLE identify the rear axle ratio (when required, a letter is also stamped or number after the rear axle code to identify the front axle). The letters and / or numerals under TAPE designate the external bodyside tape stripe. The spring usage codes for the vehicle is identified under SPRING.

A two-digit number is stamped above D.S.O. to identify the district which ordered the vehicle. If the vehicle is built to special order (Domestic Special Order, Foreign Special Order, Limited Production Option, or other special order), the complete order number will also appear above D.S.O. The following charts list the various vehicle data codes.

### **VEHICLE IDENTIFICATION NUMBER (VIN) Codes**

BRAKE SYSTEM AND GVWR CLASS FOR TRUCKS AND MPV'S —
BRAKE SYSTEM (ONLY) FOR BUSES AND INCOMPLETE VEHICLES
(VIN POSITION 4)

1FTBF25H5MLA00001

| BRAKE<br>System | GVWR<br>CLASS | GVWR RANGE                    | VIN<br>CODE |
|-----------------|---------------|-------------------------------|-------------|
| Hydraulic       | Class A       | Not greater than 3,000 pounds | A           |
| Hydraulic       | Class B       | 3,001 — 4,000 pounds          | В           |
| Hydraulic       | Class C       | 4,001 — 5,000 pounds          | С           |
| Hydraulic       | Class D       | 5,001 — 6,000 pounds          | D           |
| Hydraulic       | Class E       | 6,001 — 7,000 pounds          | E           |
| Hydraulic       | Class F       | 7,001 — 8,000 pounds          | F           |
| I budan dia     | Class G       | 8,001 — 8,500 pounds          | G           |
| Hydraulic       | Class G       | 8,501 — 9,000 pounds          | Н           |
| Hydraulic       | Class H       | 9,001 — 10,000 pounds         | J           |
| Hydraulic       | Class 3       | 10,001 — 14,000 pounds        | К           |
| Hydraulic       | Class 4       | 14,001 — 16,000 pounds        | L           |
| Hydraulic       | Class 5       | 16,001 — 19,500 pounds        | M           |

CY2674-H

### MODEL OR LINE, SERIES, CHASSIS, CAB OR BODY TYPE (VIN POSITIONS 5, 6, AND 7)

1FTB F25 H5MLA00001

| VIN           | Code           | Line          | Series | ChassisType | Cab or Body Type | Vehicle Type ① |
|---------------|----------------|---------------|--------|-------------|------------------|----------------|
| Club<br>Wagon | Super<br>Wagon |               |        |             |                  |                |
| E11           |                | Club Wagon XL | E150   | 4x2         | Club Wagon       | MPV            |
| E21           |                | Club Wagon XL | E250   | 4x2         | Club Wagon       | MPV or Bus @   |
|               | S31            | Club Wagon XL | E350   | 4x2         | Super Wagon      | MPV or Bus (a) |

Memo: One of the following optional exterior nameplates (indicating different trim levels) may also be affixed to the vehicle in addition to the Club Wagon XL nameplate: ●XLT

●No Nameplate (Trim credit option-deletes XL trim components)

@Excludes School Bus

| Regular<br>Van | Super<br>Van |           |      |     |                                     |             |
|----------------|--------------|-----------|------|-----|-------------------------------------|-------------|
| E14            | S14          | Econoline | E150 | 4x2 | Cargo Van — Regular Van/Super Van   | Truck or IV |
| E24            | S24          | Econoline | E250 | 4x2 | Cargo Van — Regular Van/Super Van   | Truck or IV |
| E25            | _            | Econoline | E250 | 4x2 | Cargo Van — HD Regular Van          | Truck or IV |
| E34            | S34          | Econoline | E350 | 4x2 | Cargo Van — Regular Van/Super Van   | Truck or IV |
| Other          |              |           |      | l   | 1                                   |             |
| E37            | _            | Econoline | E350 | 4x2 | Commercial Cutaway                  | I IV.       |
| E30            | _            | Econoline | E350 | 4x2 | RV Cutaway                          | l IV        |
| E39            | _            | Econoline | E350 | 4x2 | Commercial Basic (Stripped) Chassis | l IV        |
| E33            |              | Econoline | E350 | 4x2 | RV Basic (Stripped) Chassis         | IV          |

①"MPV" means Multi-Purpose Vehicle. "IV" means Incomplete Vehicle. "Truck" means Complete Vehicle.

Memo: For all Econoline except Basic (Stripped) Chassis, the optional exterior nameplate "XL" (indicating trim level) may also be affixed to the vehicle in addition to the Econoline nameplate.

Note: All 1988 model Commercial and RV Basic (Stripped) Chassis incomplete vehicles are designated by a "1FC" or "2FC" World Manfacturer Identifier (WMI) code. The RV Basic (Stripped) Chassis is available only on a Special Order Basis.

| VIN Code | Line   | Series | Chassis<br>Type | Cab or Body Type | Vehicle Type ① |
|----------|--------|--------|-----------------|------------------|----------------|
| U15      | Bronco | U150   | 4x4             | Bronco           | MPV            |

Memo: One of the following optional exterior nameplates (indicating higher trim levels) may also be affixed to the vehicle in addition to the Bronco nameplate: ● XLT ● Eddie Bauer

| Regular<br>Cab | Super Cab or<br>Crew Cab |          |              |     |                                   |       |
|----------------|--------------------------|----------|--------------|-----|-----------------------------------|-------|
| F14            | X14                      | F-Series | F150         | 4x4 | Pickup — Regular Cab/Super Cab    | Truck |
| F15            | X15                      | F-Series | F150         | 4x2 | Pickup — Regular Cab/Super Cab    | Truck |
| F25            | X25                      | F-Series | F250         | 4x2 | Pickup — Regular Cab/Super Cab    | Truck |
| F26            | X26                      | F-Series | F250         | 4x4 | Pickup — Regular Cab/Super Cab    | Truck |
| F35            | W35X35                   | F-Series | F350         | 4x2 | Pickup — Regular Cab/Crew Cab     | Truck |
| F37            | -                        | F-Series | F350         | 4x2 | Regular Cab (Chassis Cab)         | ) IV  |
| F36            | W36                      | F-Series | F350         | 4x4 | Pickup — Regular Cab/Crew Cab     | Truck |
| F38            | -                        | F-Series | F350         | 4x4 | Regular Cab (Chassis Cab)         | ) IV  |
| F47            | _                        | F-Series | F-Super Duty | 4x2 | Regular Cab (Chassis Cab)         | l IV  |
| F53            | 1 - 1                    | F-Series | F-Super Duty | 4x2 | RV Basic Stripped Chassis         | l IV  |
| F59            | -                        | F-Series | F-Super Duty | 4x2 | Commercial Basic Stripped Chassis | IV    |

① "MPV" means Multi-Purpose Passenger Vehicle. "IV" means Incomplete Vehicle.

Memo: One of the following optional exterior nameplates (indicating higher trim levels) may also be affixed to the vehicle in addition to the F-Series nameplates:

CY2379-K



1 F T B F 2 5 H 5 M L A 0 0 0 0 1

| VIN Codo | Displacement |     | Culindoro | Fuel     | Manufacturer |
|----------|--------------|-----|-----------|----------|--------------|
| VIN Code | Liter        | CID | Cylinders | ruei     | manufacturer |
| Y        | 4.9          | 300 | 1-6       | Gasoline | Ford         |
| N        | 5.0          | 302 | V-8       | Gasoline | Ford         |
| Н        | 5.8          | 351 | V-8       | Gasoline | Ford         |
| G        | 7.5          | 460 | V-8       | Gasoline | Ford         |
| M        | 7.3          | 445 | V-8       | Diesel   | Navistar     |

CY2380-K



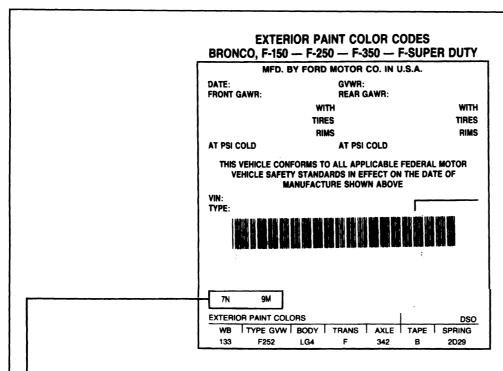
CY2381-K

VEHICLE MODEL YEAR
FOR FORD-COMPLETED VEHICLES
(VIN POSITION 10)

1FTBF25H5 M LA00001

| VIN Code | Year |  |
|----------|------|--|
| <br>Κ    | 1989 |  |
| L        | 1990 |  |
| M        | 1991 |  |
| N        | 1992 |  |

**ASSEMBLY PLANT CODES** (VIN POSITION 11) 1FTBF25H5M|L|A00001 VIN Code Vehicle Assembly Plant — Name and Location С Ontario Truck: Oakville, Ontario Н Lorain: Lorain, Ohio J Monterrey, N.L.: Mexico Kansas City: Claycomo, Missouri Michigan Truck: Wayne, Michigan L Ν Norfolk: Norfolk, Virginia Twin Cities: St. Paul, Minnesota U Louisville: Louisville, Kentucky CY2383-K PRODUCTION SEQUENCE NUMBER (VIN POSITIONS 12 THROUGH 17) 1FTBF25H5M L A 0 0 0 0 1 **SEQUENCE NUMBER** A\_00001 - A 99,000 B 00001 --- B 99,999 and so on. CY2384-K



#### **BRONCO EXTERIOR PAINT COLOR CODES**

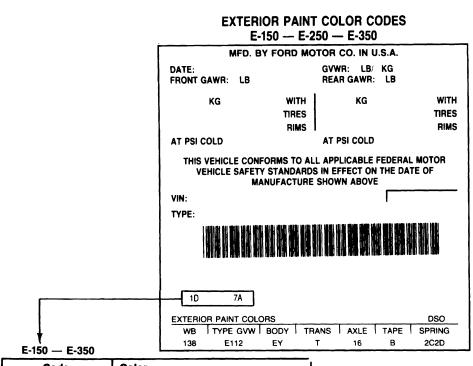
| Code      | Color                        |
|-----------|------------------------------|
| YC        | Black                        |
| YW        | Smoke Metallic               |
| YV        | Light Smoke Metallic         |
| EN        | Medium Scarlet               |
| EH        | Medium Cabernet              |
| MG        | Bright Regatta Blue Metallic |
| MJ        | Dark Shadow Blue Metallic    |
| YY        | Colonial White               |
| AT        | Desert Tan Metallic          |
| AV        | Pawnee Tan                   |
| CE        | Dark Chestnut Metallic       |
| 99        | Prime                        |
| EC        | Currant Red                  |
| PB        | Jewel Green Metallic         |
| Fiberglas | ss Roof Colors               |
| Α         | Black                        |
| В         | Blue                         |
| K         | Pawnee Tan                   |
| R         | Currant Red                  |
| W         | White                        |

NOTE — TWO SETS OF CODES INDICATE TWO-TONE PAINT

### F-150 — F-350 AND F-SUPER DUTY EXTERIOR PAINT COLOR CODES

| Code | Color                        |
|------|------------------------------|
| YC   | Black                        |
| YW   | Smoke Metallic               |
| YV   | Light Smoke Metallic         |
| EN   | Medium Scarlet               |
| EH   | Medium Cabernet              |
| MG   | Bright Regatta Blue Metallic |
| MJ   | Dark Shadow Blue Metallic    |
| YY   | Colonial White               |
| AT   | Desert Tan Metallic          |
| AV   | Pawnee Tan                   |
| CE   | Dark Chestnut Metallic       |
| 99   | Prime                        |
| PB   | Jewel Green Metallic         |
| RC   | Medium Platinum              |
| YN   | Silver Metallic              |
| A9   | Chestnut                     |
| A8   | Dark Chestnut                |
| MA   | Light Crystal Blue           |
| EC   | Currant Red                  |
| PB   | Jewel Green Metallic         |
| MK   | Twilight Blue                |
| EL   | Wild Strawberry              |

CY2668-H

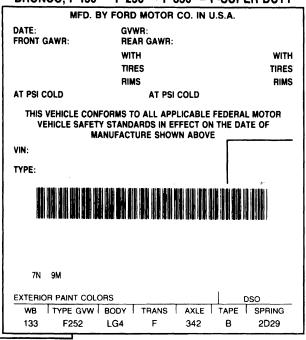


| Code | Color                |  |  |
|------|----------------------|--|--|
| ZC   | Glacier White        |  |  |
| EM   | Medium Red           |  |  |
| 99   | Prime                |  |  |
| YY   | White                |  |  |
| AV   | Pawnee Tan           |  |  |
| RC   | Medium Platinum      |  |  |
| YN   | Silver               |  |  |
| A8   | Dark Chestnut        |  |  |
| A4   | Desert Tan           |  |  |
| K2   | Atlantic Blue        |  |  |
| MA   | Light Crystal Blue   |  |  |
| DD   | Mocha Frost          |  |  |
| EC   | Currant Red          |  |  |
| YC   | · Black              |  |  |
| DC   | Medium Mocha         |  |  |
| EG   | Electric Currant Red |  |  |
| MK   | Twilight Blue        |  |  |

NOTE: Two sets of codes indicate two-tone paint.

CY2794-F

### TYPE — GROSS VEHICLE WEIGHT (GVW) CODES BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY



| Series | Series<br>Code | GVWR<br>Code | GVWR<br>(lb.) | Wheelbase (in.) |
|--------|----------------|--------------|---------------|-----------------|
| Bronco |                |              |               |                 |
| U150   | U15            | 2            | 6050          | 105             |
|        | U15            | 4            | 6300          | 105             |
|        | U15            | 5            | 6450          | 105             |

F25

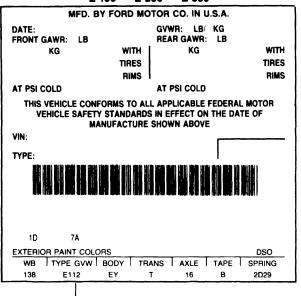
2

| F-150 — F-250 — F-350     |     |   |      |     |  |  |
|---------------------------|-----|---|------|-----|--|--|
| F-150 (4x2)               | F15 | 3 | 5250 | 117 |  |  |
| , ,                       | F15 | 4 | 5450 | 133 |  |  |
|                           | F15 | 5 | 6250 | 133 |  |  |
|                           | X15 | 1 | 6050 | 139 |  |  |
|                           | X15 | 2 | 6250 | 155 |  |  |
| F-150 (4x4)               | F14 | 1 | 6100 | 117 |  |  |
| , ,                       | F14 | 2 | 6250 | 133 |  |  |
|                           | X14 | 3 | 6250 | 139 |  |  |
|                           | X14 | 1 | 6250 | 155 |  |  |
| F-250 (4x2)<br>Light Duty | F25 | 1 | 6600 | 133 |  |  |
| F-250 (4x2)               | F25 | 7 | 8600 | 133 |  |  |
| Heavy Duty                | X25 | 9 | 8800 | 155 |  |  |

| Series   | Series<br>Code                                | GVWR<br>Code                    | GVWR<br>(lb.)  | Wheelbase<br>(in.)                                      |
|--|---|---------------------------------|--|---|
| F-250 (4x4)                                    | F26<br>X26<br>F26                             | 1<br>8<br>8                     | 6800<br>8800<br>8600                                 | 133<br>155<br>133                                       |
| F-350 (4x2)                                    | F35<br>F37<br>F37<br>F37<br>W35<br>W35<br>X35 | 2<br>4<br>8<br>9<br>2<br>3<br>1 | 10,000<br>8800<br>10,000<br>11,000<br>9200<br>10,000 | 133<br>133<br>137, 161<br>137, 161<br>168<br>168<br>155 |
| F-350 (4x4)                                    | F36<br>F38<br>F38<br>W36                      | 1<br>2<br>4<br>1                | 9000<br>8800<br>11,000<br>9200                       | 133<br>133<br>137, 161<br>168                           |
| F-Super Duty<br>(4x2) Chassis Cab              | F47   | 6                               | 14,500   | 137, 161  |
| F-Super Duty<br>Commercial<br>Stripped Chassis | F59   | 1                               | 16,000   | 158, 178  |
| F-Super Duty<br>Motor Home<br>Stripped Chassis | F53   | 1                               | 17,000   | 178, 208  |

CY2669-H

### GROSS VEHICLE WEIGHT (GVW) CODES E-150 — E-250 — E-350



E11

2

E-150 — E-350 CLUB — XL AND XLT WAGONS

| Series             | Series<br>Code | GVWR<br>Code | GVWR<br>(lb.) |
|--------------------|----------------|--------------|---------------|
| E-150 Conventional | E11            | 2            | 6,600         |
| E-250 Conventional | E21            | Р            | 8,550         |
| E-350 Super        | S31            | 5            | 9,100         |

### E-150 - E-350 CARGO VANS

| Series                   | Series<br>Code | GVWR<br>Code | GVWR<br>(lb.) |
|--------------------------|----------------|--------------|---------------|
| E-150 Conventional Cargo | E14            | 1            | 5,500         |
|                          | E14            | 2            | 6,100         |
|                          | E14            | 3            | 6,500         |
|                          | E24            | 3            | 8,550         |
| E-150 Super Cargo        | S14            | 1            | 6,200         |
| E-250 Conventional Cargo | E24            | 1            | 7,200         |
|                          | E24            | 2            | 7,900         |
| E-250 Super Cargo        | S24            | 1            | 8,100         |
| E-350 Conventional Cargo | E34            | 1            | 9,400         |
|                          | E34            | 2            | 9,500         |
| E-350 Super Cargo        | S34            | 1            | 9,000         |

### E-350 RV CUTAWAY

| Series           | Series<br>Code | GVWR<br>Code | GVWR<br>(lb.) |
|------------------|----------------|--------------|---------------|
| E-350 RV Cutaway | E30            | 2            | 10,500 DR     |
|                  | E30            | 3            | 11,000 DR     |
|                  | E30            |              | 11,500 DR     |

SR: Single Rear Wheels DR: Dual Rear Wheels

#### E-350 COMMERCIAL CUTAWAY

| Series                       | Series<br>Code | GVWR<br>Code | GVWR<br>(lb.) |
|------------------------------|----------------|--------------|---------------|
| E-350 Commercial Cutaway Van | E37            | 1            | 10,000 DR     |
|                              | E37            | 2            | 10,300 DR     |
|                              | E37            | 3            | 10,700 DR     |

SR: Single Rear Wheels DR: Dual Rear Wheels

#### E-350 COMMERCIAL STRIPPED CHASSIS VAN

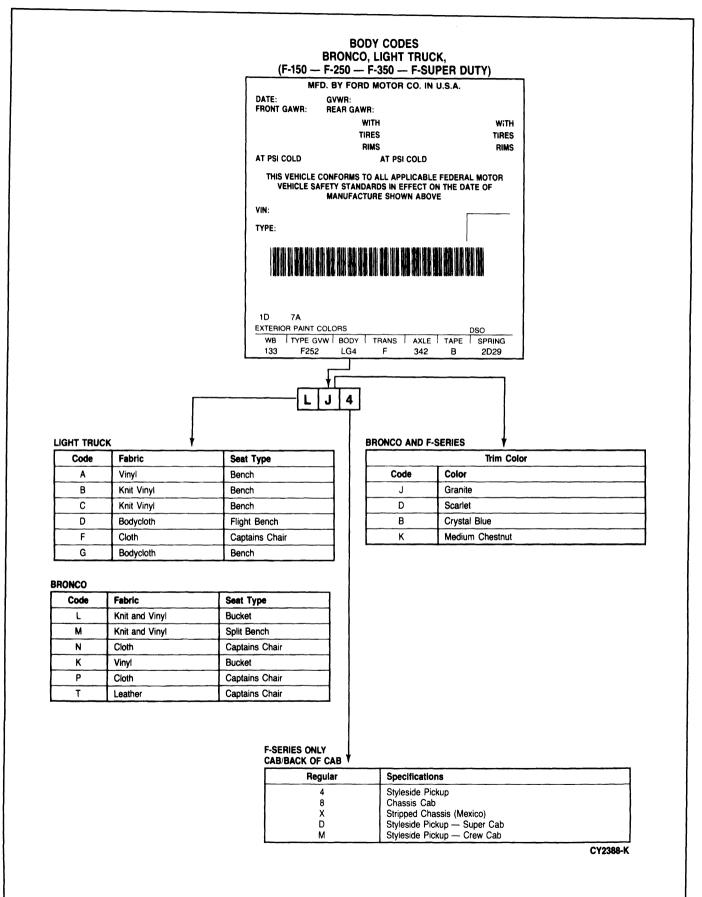
| Series                                   | Series<br>Code | GVWR<br>Code | GVWR<br>(lb.) |
|--|----------------|--------------|---------------|
| E-350 Commercial Stripped<br>Chassis Van | E39            | U            | 9,400 SR      |
|  | E39            | W            | 10,000 DR     |

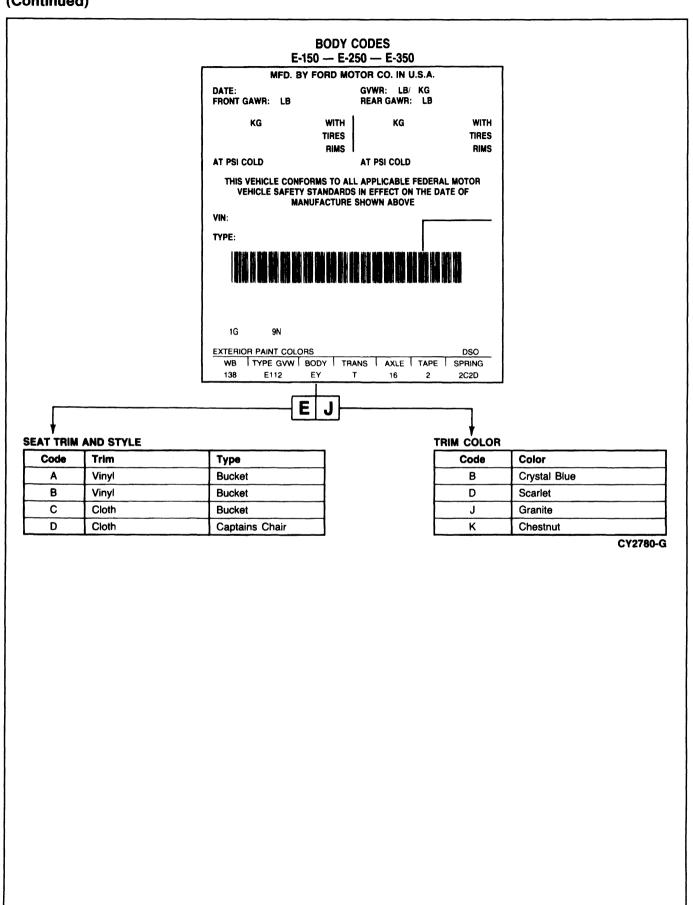
SR: Single Rear Wheels DR: Dual Rear Wheels

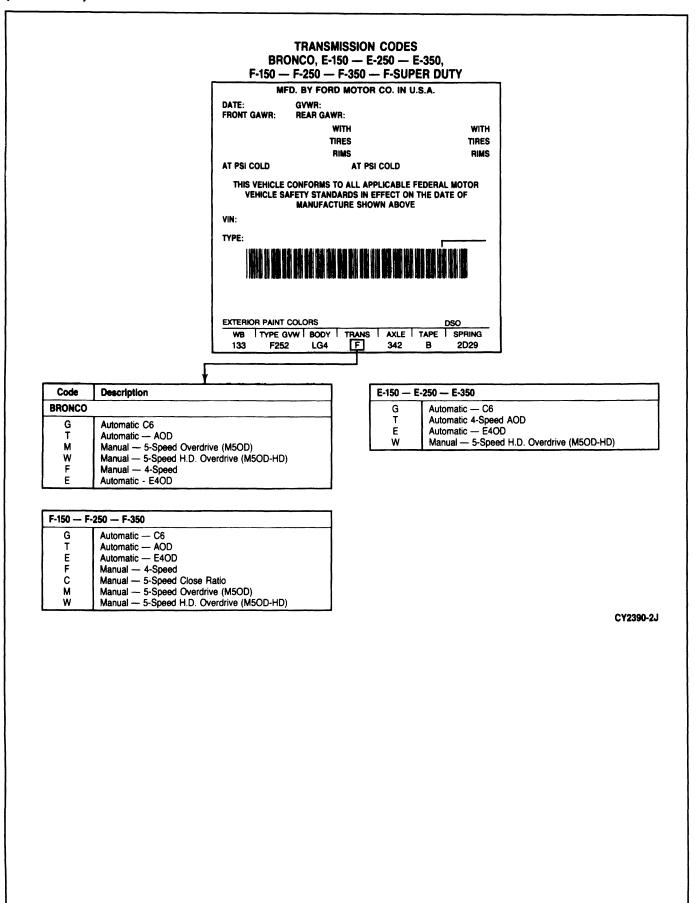
### E-350 STRIPPED CHASSIS

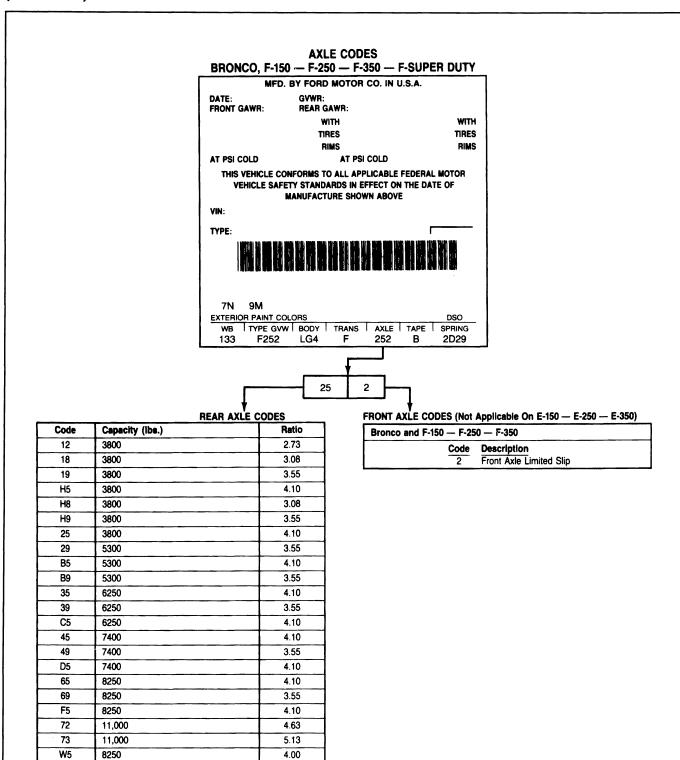
| Series                    | Series | GVWR | GVWR      |
|---------------------------|--------|------|-----------|
|                           | Code   | Code | (lb.)     |
| E-350 RV Stripped Chassis | E33    | Υ    | 11,500 DR |

CY2779-G









CY2671-2G

### **AXLE CODES** E-150 — E-250 — E-350 MFD. BY FORD MOTOR CO. IN U.S.A. DATE: GVWR: LB/ KG FRONT GAWR: LB REAR GAWR: LB KG WITH KG WITH TIRES TIRES RIMS RIMS AT PSI COLD AT PSI COLD THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE VIN: TYPE: 1D 7A EXTERIOR PAINT COLORS DSO WB TYPE GVW | BODY | TRANS | AXLE | TAPE | SPRING

Т

18

В

E-150 — E-250 — E-350 REGULAR REAR AXLE

| Code | # Capacity | Ratio |
|------|------------|-------|
| 18   | 3800       | 3.08  |
| 19   | 3800       | 3.55  |
| 23   | 5400       | 3.54  |
| 24   | 5400       | 3.73  |
| 33   | 6340       | 3.54  |
| 52   | 7800       | 4.10  |
| 53   | 7800       | 3.54  |
| 32   | 6340       | 4.10  |
| 62   | 8000       | 4.10  |

138

E112

ΕY

E-150 — E-250 — E-350 LIMITED SLIP REAR AXLE

2C2D

| Code | # Capacity | Ratio |
|------|------------|-------|
| H9   | 3800       | 3.08  |
| B4   | 5400       | 3.73  |
| C2   | 6340       | 4.10  |
| C3   | 6340       | 3.54  |
| E2   | 7800       | 4.10  |

CY2781-F

### EXTERNAL BODY TAPE STRIPE CODES BRONCO, E-150 — E-250 — E-350, F-150 — F-250 — F-350 — F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A. GVWR: DATE: FRONT GAWR: REAR GAWR: WITH WITH TIRES TIRES RIMS RIMS AT PSI COLD AT PSI COLD THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE VIN: TYPE: 7N EXTERIOR PAINT COLORS DSO WB TYPE GVW BODY TRANS AXLE TAPE SPRING F252 LG4 342 2D29 U

#### **BRONCO EXTERNAL TUTONE BODY TAPE STRIPE CODES**

| Code | Tape Stripe  |
|------|--|
| 1    | Light Regatta Blue/Bright Regatta Blue   |
| 2    | Light Chestnut/Light Desert Tan  |
| 3    | Medium Charcoal/Red Orange   |
| U    | Light Chestnut — Paint Stripe with Light Desert Tan/Light Chestnut — Tape Break Stripe |
| S    | Pale Slate/Rose Quartz   |

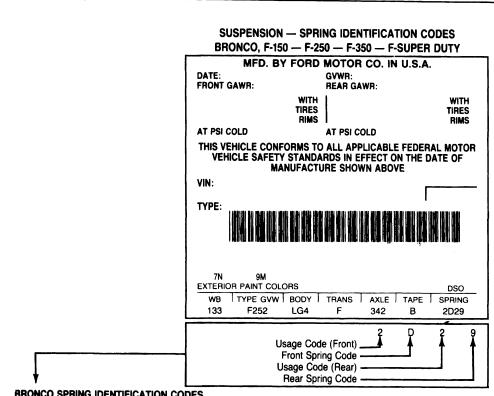
### F-150 — F-350 ALL TUTONES TAPE) REGULAR AND VICTORIA TUTONES (TAPE)

| Code | Tape Stripe                            |
|------|--|
| 1    | Light Regatta Blue/Bright Regatta Blue |
| 2    | Light Chestnut/Light Desert Tan        |
| 3    | Medium Charcoal/Red Orange             |

### F-150 — F-350 EXTERNAL BODY TAPE STRIPE CODES XL SRW STYLESIDE SOLID PAINT (PAINT STRIPE) LESS CHAMFER STRIPES

| Code | Lacquer Stripe |
|------|----------------|
| 1    | Red Orange     |
| 2    | Grabber Blue   |
| 3    | Copper         |
| 4    | Light Chestnut |
| 5    | Medium Gray    |

CY2672-H



**BRONCO SPRING IDENTIFICATION CODES** 

Aux./Opt. Usage Code (Front) — Not Applicable Aux./Opt. Usage Code (Rear) — Not Applicable FRONT SPRING CODES — BRONCO REAR SPRING CODES — BRONCO

| Code | Part Number  |
|------|--------------|
| В    | E0TA-5310-BC |
| C    | E0TA-5310-CC |
| G    | E0TA-5310-GC |
| U    | E0TA-5310-UC |
| ٧    | E0TA-5310-VB |

| Code | Part Number   |  |
|------|---------------|--|
| Z    | E3TA-5560-ANA |  |

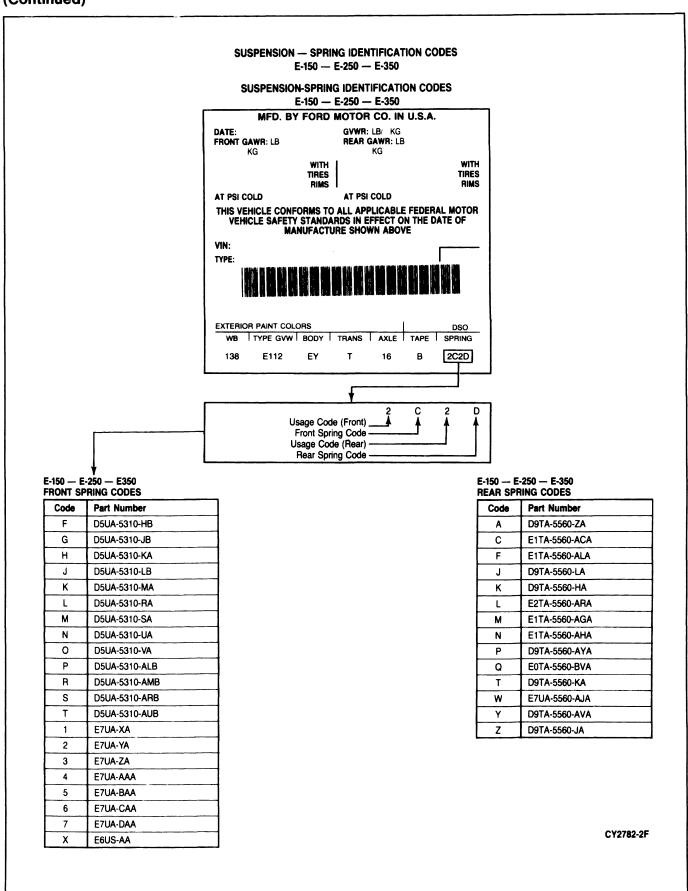
F-150 — F-250 — F-350 — F-SUPER DUTY FRONT SPRING CODES

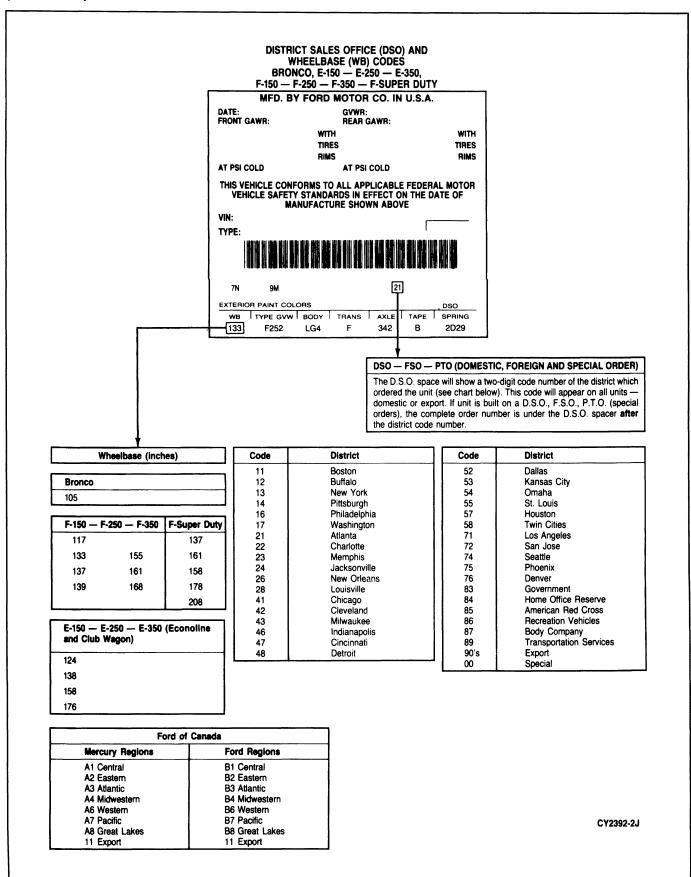
| Code | Part Number   |
|------|---------------|
| A    | E0TA-5310-AC  |
| В    | E0TA-5310-BC  |
| С    | E0TA-5310-CC  |
| D    | E0TA-5310-DC  |
| E    | E0TA-5310-EC  |
| F    | E0TA-5310-FC  |
| G    | E0TA-5310-GC  |
| Н    | E3TA-5310-XA  |
| J    | E3TA-5310-YA  |
| K    | E3TA-5310-ZA  |
| М    | E3TA-5310-AAA |
| N    | E5TS-5310-BA  |
| R    | E5TA-5310-RA  |
| S    | E5TA-5310-SA  |
| T    | E5TA-5310-TA  |
| U    | E0TA-5310-UC  |
| ٧    | E0TA-5310-VB  |
| 5    | E0TA-5310-AAB |
| 6    | E0TA-5310-ABB |
| 7    | E0TA-5310-ACB |
| 8    | E5TA-5310-NA  |
| 9    | E3TA-5310-ABA |

F-150 — F-250 — F-350 — F-SUPER DUTY REAR SPRING CODE

| Code | Part Number  |
|------|--------------|
| Α    | E4TA-5560-SA |
| D    | E7TA-5560-NA |
| F    | E7TA-5560-FA |
| L    | E3TA-5560-KA |
| ٧    | E7TA-5560-RA |
| Υ    | E7TA-5560-YA |
| 6    | E4TA-5560-EA |
| 7    | E7TA-5560-KA |
| 8    | E9TA-5560-AA |

CY2673-2F





### **SECTION 00-03 Maintenance and Lubrication**

| SUBJECT PAGE                                       | SUBJECT             | PAG    |
|--|---------------------|--------|
| LUBRICATION CHART00-03-13                          |                     |        |
| MAINTENANCE Scheduled Maintenance Emissions00-03-1 | VEHICLE APPLICATION | 00-03- |

### **VEHICLE APPLICATION**

E-150—E-350, F-150—F-350 and F-Super Duty, and Bronco Vehicles

### **MAINTENANCE**

The scheduled and non-scheduled maintenance recommendations are included in this section for reference. The emission systems scheduled maintenance services and the vehicle maintenance services are separated. Be sure to perform all maintenance services by referring to both Sections of the schedule.

It should be noted, however, that any modification of the emission control systems could create liability under Federal Law (U.S.) if made prior to the first sale and registration and, under the laws of some states, if made thereafter. Further, federal law prohibits vehicle manufacturers or dealers and other persons engaged in the business of repairing, servicing, selling, leasing, or trading motor vehicles as well as fleet operations from knowingly removing or rendering an emission control system inoperative after sale and delivery to an ultimate purchaser. In Canada, modifications of the emission control system could create liability under applicable Federal or Provincial laws.

#### **Scheduled Maintenance Emissions**

An Emission Systems Required Maintenance Chart for each truck model is listed on the following pages.

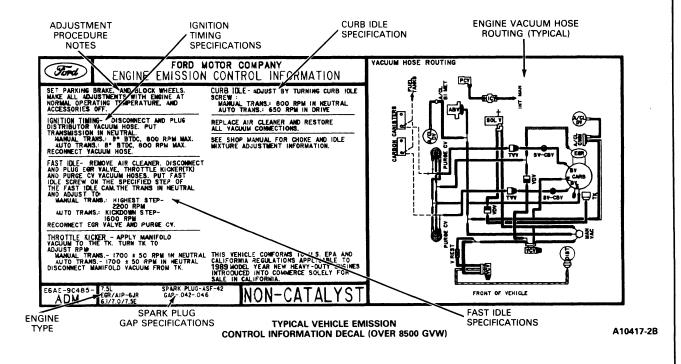
The Emission Systems Required Maintenance Chart lists the items required to maintain the vehicle emission systems at levels determined by the Federal Government (Environmental Protection Agency). Refer to the appropriate Sections of the Engine Shop Manual and the Engine / Emission Diagnosis Manual\* for the Maintenance Procedures, which are related to the items listed on the maintenance schedule. Use these procedures to perform the required emission system maintenance items listed on the maintenance charts.

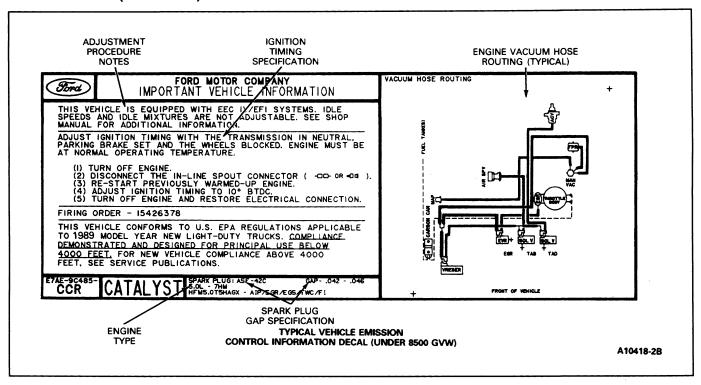
Maintenance service adjustments must conform to specifications contained in the Engine / Emissions Diagnosis Manual,\* to those listed in the Truck Performance Specifications issue of the Technical Service Bulletin or shown on the Vehicle Emission Control Information Decal which is located on or near the engine, or the emission systems may become inoperative.

If an engine is equipped with a "Dura-Spark" ignition system and any high tension ignition wire was detached from a spark plug, the distributor cap, or the coil to perform a maintenance operation, Silicone Dielectric Compound D7AZ-19A331-A (ESA-M1C171-A) or equivalent, must be applied to the boot before reconnection. Using a small clean screwdriver, apply a thin layer of Silicone Dielectric Compound on the entire interior surface of the boot.

As a safety precaution, before starting the engine to perform maintenance, make sure the transmission selector is in Park (Automatic Transmission) or Neutral (Manual Transmission), the parking brake set and the wheels blocked.

TO ASSURE THE DURABILITY OF YOUR VEHICLE AND ITS EMISSION CONTROL SYSTEMS IT IS **NECESSARY THAT SCHEDULED MAINTENANCE** BE PERFORMED AT THE DESIGNATED INTERVALS. FORD RECOMMENDS THE USE OF **GENUINE FORD REPLACEMENT PARTS. YOU** MAY, HOWEVER, ELECT TO HAVE MAINTENANCE, REPLACEMENT, OR REPAIR OF THE EMISSIONS CONTROL DEVICES AND SYSTEMS (THE COST OF WHICH IS NOT **COVERED BY WARRANTY) PERFORMED BY ANY AUTOMOTIVE REPAIR ESTABLISHMENT OR** INDIVIDUAL AND MAY ELECT TO USE OTHER THAN FORD SERVICE PARTS FOR SUCH MAINTENANCE OR REPAIR. IF OTHER THAN FORD OR MOTORCRAFT PARTS OR FORD **AUTHORIZED, REMANUFACTURED PARTS ARE USED FOR MAINTENANCE REPLACEMENTS OR** FOR THE SERVICE OF COMPONENTS AFFECTING **EMISSIONS CONTROL, THE OWNER SHOULD** ASSURE HIMSELF THAT SUCH PARTS ARE WARRANTED BY THEIR MANUFACTURER TO BE **EQUIVALENT TO GENUINE FORD MOTOR COMPANY PARTS IN PERFORMANCE AND DURABILITY. PLEASE CONSULT YOUR** WARRANTY BOOKLET FOR COMPLETE WARRANTY INFORMATION.





#### Maintenance Schedule Applicable To Bronco, E-150, E-250, E-350 and F-150, F-250, F-350, F-Super Duty Trucks

Three maintenance schedules are specified for the 1991 model Bronco, Econoline and F-Series trucks. They are identified by the letters B, E and G. The application of the various maintenance schedules are as follows:

### Catalyst Equipped Vehicles Require Unleaded Fuel Only

### Maintenance Schedule "B" — Gasoline Engine Equipped Vehicles with Light Duty Emissions (Under 8500 Pounds GVWR)

The following catalyst equipped vehicles, designated for use with "Unleaded Fuel Only" should be maintained according to Maintenance Schedule "B."

- F-150
- F-250
- E-150/E-250 and Club Wagon
- Bronco

### Catalyst Equipped Vehicles Require Unleaded Fuel Only

### Maintenance Schedule G — Gasoline Engine Equipped Vehicles with Heavy Duty Emissions (Over 8500 Pounds GVWR)

The "G" maintenance schedule is used for the following unleaded fuel vehicles with 4.9L 5.8L and 7.5L EFI engines.

- F-150/F-250/F-350
- F-Super Duty
- E-250/E-350 and Club Wagon

### Maintenance Schedule "E"—7.3L Diesel Engine Equipped Vehicles

The "E" maintenance schedule is used for the following Diesel Engine Equipped Vehicles:

- Heavy Duty F-250
- F-350
- F-Super Duty
- Heavy Duty E-250
- E-350

### REQUIRED MAINTENANCE SERVICE PROCEDURES

Refer to the appropriate Sections of the Engine Shop Manual and the Engine / Emission Diagnosis\* manual for the required maintenance service procedures.

<sup>\*</sup>Can be purchased as a separate item.

#### MAINTENANCE SCHEDULE B — NORMAL DRIVING CONDITIONS

F-150/250 and Bronco Unleaded Fuel Vehicles with Light Duty Emissions (Under 8,500 lbs. GVWR)

B - Required for all vehicles.

b — Required for 49 States vehicles and recommended only for California and Canada vehicles. Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(b) — This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(b)" in order to achieve best

| NORMAL DRIVING   | SERVICE INTERVALS — PERFO          | ORM A    | THE  | MONT   | HS OF    | DIST   | ANCES          | SHO  | NN, W    | HICHE  | VER (        | CCUR           | S FIR        | ST.                 |          |              |             |
|--|------------------------------------|----------|--|--|----------|--|----------------|--|----------|--|--------------|----------------|--------------|---------------------|----------|--------------|-------------|
| MAINTENANCE OPERATION                                      | MILES (Thousands)                  | 7.5      | 15   | 22.5   | 30       | 37.5   | 45             | 52.5   |          | 67.5   | 75           | 82.5           |              | 97.5                |          | 112.5        | _           |
| F-I-I-O-I-I-O-I  | KILOMETERS (Thousands)             | 12       | 24   | 36   | 48       | 60   | 72             | 84   | 96       | 108  | 120          | 132            | 144          | 156                 | 168      | 181          | 19          |
| Emission Control Systems                                   | 0                                  |          | _  | _  |          |  | _              | -  |          |  |              |                |              |                     |          | -            | <del></del> |
| Change Engine Oil and Oil Filter — ever                    | 6 months OH                        | В        | В  | В  | В        | В  | В              | В  | В        | В  | В            | В              | В            | В                   | В        | <u>B</u>     | ٩           |
| Replace Spark Plugs — Standard                             |                                    |          |  |  | В        | <b></b>  | <u> </u>       | ļ  | ь        |  |              | _              | ٥            | ├                   |          | <b>├</b> ─   | ٩           |
| Replace Coolant — every 36 months OR                       |                                    | لـــــا  | لـــا  |  | В        |  |                | L  | B        | 141117   | L            | l              | В            | L                   | L        | <u> </u>     | l t         |
| Check Cooling System, Hoses and Clamp                      | 18                                 |          |  |  |          | _  |                |  |          | JALLY  |              |                |              | т                   |          | T            | T .         |
| Replace Air Cleaner Filter                                 |                                    |          |  |  | В        | -  |                |  | ь        |  | ├            | ├              | ь            |                     | <u> </u> |              | Ľ           |
| Replace Crankcase Emission Filter                          | - Make                             |          |  |  | В        | -  | <del> </del>   | <b>├</b> ──                                      | b (5)    | ├  | ├            | <del>├</del> ─ | ь            | <del> </del>        |          | ├            | Ļ           |
| Check/Clean Idle Speed Control Air Bypa                    | ss valve                           | $\vdash$ |  |  |          |  | <b> </b>       | ├—   | (b)      |  |              | <b>├</b> ─     | ├—           | $\vdash$            |          | }            | L           |
| Check/Clean Throttle Body Replace PCV Valve                |                                    | $\vdash$ |  |  |          |  | <del> </del>   | ├  | (b)      | <del>                                     </del> |              | <del> </del>   | ├            |                     | -        | Н—           | 1           |
|  |                                    | <u> </u> |  | -  |          |  |                | ├  | b/1<br>b | ├—   |              | ├              | ├            | -                   | <u> </u> | $\vdash$     | H           |
| Replace Ignition Wires  Check Thermactor Hoses and Clamps# |                                    |          |  |  |          |  | <del> </del>   | <del>                                     </del> | Ь        | ╁  | ├            | ├              | <del> </del> |                     | <b> </b> | <del> </del> | H           |
| Inspect Drive Belt Condition                               |                                    |          |  |  |          | <u> </u>   |                | <b>├</b>   | Ь        | }—   | ├            | ├              |              | -                   | ├        | <b>├</b>     | H           |
| Other Systems  |                                    |          | Ц  | L  | L        | L  | L              | L  | U        | <u> </u>   | <u> </u>     | <u> </u>       | L            | L                   |          | L            |             |
| Change Rear Axle Lube                                      |                                    | _        |  |  | г        |  | ·              | т —  | Ι        | 1  | г —          | т —            | r            |                     | В        | _            | т           |
| Check Wheel Lug Nut Torque*                                |                                    | В        | В  | В  | В        | В  | В              | В  | В        | ╁──  | -            | ┼—             |              |                     | P        | ╁            | ╁           |
| Check Clutch Reservoir Fluid Level                         |                                    | B        | В  | В  | В        | В  | В              | В  | В        | ├  | <del> </del> | ┼              | ├            | <del> </del>        | -        | $\vdash$     | ╁           |
| Lubricate Transfer Case Shift Lever Pivot                  | Bolt and Control Rod               |          |  | Ľ  | <u> </u> | ۳  | <del>-</del> - | ╁  | <u> </u> | ├  | <del> </del> | <del> </del>   | <del> </del> |                     |          | ┢─           | ╁           |
| Connecting Pins  | Dok and Control Floo               |          | В  |  | В        |  | В              | 1  | В        |  | l            | 3              |              | 1                   | 1        |              | L           |
| Inspect and Lubricate Automatic Transmissio                | n Shift Linkage (Bellcrank System) | В        | В  | В  | В        | В  | В              | В  | В        |  |              |                |              |                     |          |              | _           |
| Inspect and Lubricate Front Wheel Bearing                  | lgs                                |          |  |  | В        |  |                | 1  | В        | 1  |              |                |              |                     |          |              |             |
| Rotate Tires   |                                    | В        | В  |  | В        |  | В              |  | В        | 1  |              |                |              |                     |          |              |             |
| Inspect Disc Brake System and Lubricate                    | Caliper Slide Rails                |          | В  |  | В        | 1  | В              |  | В        | 1  |              |                |              |                     |          |              |             |
| Inspect Drum Brake Systems, Hoses, an                      |                                    | 1        | В  | <u> </u>   | В        |  | В              | 1  | В        | 1  |              |                |              |                     |          |              |             |
| Inspect Exhaust System for Leaks, Dama                     |                                    |          |  |  | В        |  | <b>†</b>       | t —  | В        | 1  |              |                |              |                     |          |              |             |
| Inspect and Remove any Foreign Material Tr                 | ·                                  | В        | В  | В  | В        | В  | В              | В  | В        | 1  |              |                |              | miles/9             |          |              |             |
| Inspect Parking Brake System for Damag                     | <u> </u>                           | _        | Ħ  | <u> </u>   | В        | <u> </u>   | 1              |  | В        | 1  |              |                |              | ended r<br>ervals i |          |              |             |
| Lubricate Throttle Ball Stud                               |                                    | <b>-</b> | <del>                                     </del> | <del>                                     </del> | В        | <del>                                     </del> | $\vdash$       | t  | B        | 1  | ope          |                |              | es/96 (             |          |              |             |
| Lubricate Steering Linkage, Driveshaft U-                  | Joints, and Slip Yoke              | <u> </u> | -  | ١.   | F        | 1  | <u> </u>       | t <u>.                                    </u>   | ╁╌       | 1  |              |                |              |                     |          |              |             |
| if equipped with Grease Fittings                           |                                    | В        | В  | В  | В        | В  | В              | В  | В        | ]  |              |                |              |                     |          |              |             |
| Lubricate Caliper Slide Rails                              |                                    |          | В  |  | В        |  | В              |  | В        |  |              |                |              |                     |          |              |             |
| Lubricate Front Axie Spindle Pins (F-350                   | 4x4)                               | В        | В  | В  | В        | В  | В              | В  | В        | 1  |              |                |              |                     |          |              |             |
| Inspect Spindle Needle Bearing Lubrication                 | on (4x4)                           |          |  |  | В        | Г  | Γ              | T  | В        | 1  |              |                |              |                     |          |              |             |
| Inspect Hub Lock Lubrication (4x4)                         |                                    |          |  |  | В        |  | Π              | I  | В        | 1  |              |                |              |                     |          |              |             |
| Change Transfer Case Oil (4x4)                             |                                    |          |  |  |          |  |                |  | В        | 1  |              |                |              |                     |          |              |             |
| Change Manual Transmission Oil (ZFHD                       | M50D/S5-42 and Warner T18)         | 1        |  |  |          |  |                |  | В        | 1  |              |                |              |                     |          |              |             |

- Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.
- Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation. See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.
- /1 At 80,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles
- Check means a functional measurement of Systems' operation (performance, leaks or conditions of parts). Correct as required NOTE: Refer to page 2 of the Maintenance Schedule Record Log book for "NO COST PCV VALVE REPLACEMENT."

### UNIQUE DRIVING CONDITIONS

- If your driving habits FREQUENTLY include one or more of the following conditions:
- Short trips of less than 10 miles (16 km) when outside temperatures remain below freezing.
   Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
   Operating in severe dust conditions.
   Operating during hot weather in stop-and-go "rush hour" traffic.
   Extensive iding, such as police, taxi or door-to-door delivery use.
   Show identifies.

- High speed operation with a fully loaded vehicle (Max. GVW).
   Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever

Check/regap spark plugs every 15,000 miles (24 000 km).

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

— If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC/ID MANUAL 5-SPEED (\$5-42) TRANSMISSION FLUID — Change each 30,000 miles (48 000 km) — if your driving habits frequently include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide-in camper.
   Door-to-door delivery, police or taxi.
   Operating a transmission mounted PTO.

  EXTREME SERVICE ITEMS

if your vehicle is operated off-highway, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

Lubricate front axis spindle pins, steering and clutch linkages, axie and driveshaft U-joints

- Lubricate front axle spindle pins, steering and clutch linkages, axle and cand slip yoke if equipped with fittings.
  Inspect front wheel bearings and lubrication.
  Lubricate automatic transmission external controls (Belkrank system).
  Inspect disc brake system, lube calipre slide rails.
  Inspect drum brake system, loses and lines.
  Inspect exhaust system for leaks, damage or loose parts.
  Lubricate clutch release lever pivot (7.3L and 7.5L).

CA13378-C

### MAINTENANCE SCHEDULE G — NORMAL DRIVING CONDITIONS

F-250 HD/350 and Super Duty Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L EFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G — Required for all vehicles
g — Required for 49 States vehicles and recommended only for California and Canada vehicles.
Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(g) = This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(g)" in order to achieve heat rehicle coemics. Seiture to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

|                                     | NORMAL DRIVING SERVI       | CE | INTE | RVA | LS - | - PI | ERF | ORM | AT | THE | MON | THS | OR  | DIST | ANCES | SHO   | VN, W | HICHE | VER C | CCUR | S FIRS | ST. |     |     |     |
|-------------------------------------|----------------------------|----|------|-----|------|------|-----|-----|----|-----|-----|-----|-----|------|-------|-------|-------|-------|-------|------|--------|-----|-----|-----|-----|
| MAINTENANCE                         | MILES (Thousands)          | 5  | 10   | 15  | 20   | 25   | 30  | 35  | 40 | 45  | 50  | 55  | 69  | 65   | 70    | 75    | 80    | 85    | 8     | 95   | 100    | 105 |     | 115 | 120 |
| OPERATION                           | KILOMETERS (Thousands)     | 8  | 16   | 24  | 32   | 40   | 48  | 56  | 64 | 72  | 80  | 88  | 96  | 104  | 112   | 120   | 128   | 136   | 144   | 152  | 160    | 168 | 177 | 184 | 193 |
| mission Control                     | Systems                    |    |      |     |      |      |     |     |    |     |     |     |     |      |       |       |       |       |       |      |        |     |     |     |     |
| Change Engine (<br>every 6 months ( | Oil and Oil Fitter —<br>OR | G  | G    | G   | G    | G    | G   | G   | G  | G   | G   | G   | G   | G    | G     | G     | G     | G     | G     | G    | G      | G   | G   | G   | G   |
| Replace Spark P                     | lugs                       |    |      |     | Г    |      | G   |     |    |     |     |     | g   |      |       |       |       |       | g     |      |        |     |     |     | g   |
| Replace Engine<br>every 36 months   | Coolant —<br>OR            |    |      |     |      |      | G   |     |    |     |     |     | G   |      |       |       |       |       | G     |      |        |     |     |     | 9   |
| *Check Cooling S                    | ystem, Hoses and Clamps    |    |      |     |      |      |     |     |    |     |     |     |     |      | ANNL  | JALLY |       |       |       |      |        |     |     |     |     |
| Replace Air Clea                    | ner Filter                 |    | Π    |     | Г    | Г    | G   | Г   |    |     |     |     | 9   |      |       |       |       |       | g     |      |        |     |     |     | g   |
| Replace Crankca                     | se Emission Filter         |    |      |     |      |      | G   |     |    |     |     |     | 9   |      |       |       |       |       | g     |      |        |     |     |     | g   |
| Replace PCV Va                      | lve                        |    |      |     | П    | T .  |     |     |    |     |     |     | g/1 |      |       |       |       |       |       |      |        |     |     |     | g   |
| *Replace Ignition                   | Wires                      | Г  | П    |     | Г    |      | П   | Г   |    |     |     |     | g   |      |       |       |       |       |       |      |        |     |     |     | g   |
| *Check Thermacto                    | or Hoses and Clamps#       |    | П    |     | Г    |      |     |     |    |     |     |     | g   |      |       |       |       |       |       |      |        |     |     |     | 9   |
| \$Check/Clean Idle<br>Bypass Valve  | Speed Control Air          |    |      |     |      |      |     |     |    |     |     |     | (g) |      |       |       |       |       |       |      |        |     |     |     | (g) |
| \$Check/Clean Thr                   | ottle Body                 |    |      |     |      |      |     | Г   |    |     |     |     | (g) |      |       |       |       |       |       |      |        |     |     |     | (g) |
| Inspect Drive Be                    | It Condition               | T  | T    | G   |      |      | G   | 1   |    | G   |     |     | G   |      |       |       |       |       | G     |      |        |     |     |     | G   |

- Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.
- Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles equipped with dual rear wheels or equipped for snowplowing). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

/1 At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost except Canada vehicles.

Check means a functional measurement of Systems' operation (performance, leaks or condition of parts). Correct as required. NOTE: Refer to page 2 of the Maintenance Schedule Record Log book for "NO COST PCV VALVE REPLACEMENT."

\$On 5.0L and 5.8L engines because of the new anti-sludge throttle body, the idle speed control air by-pass valve must be removed from the throttle body before cleaning.

#### UNIQUE DRIVING CONDITIONS

- UNIQUE DRIVING CONDITIONS
  If your driving habits FREQUENTLY include one or more of the following conditions:
  Short trips of less than 10 miles (16 km) when outside temperatures remain below freezing.
  Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
  Operating in severe dust conditions.
  Operating during hot weather in stop-and-go "rush hour" traffic.
  Extensive Idling, such as police, taxi or door-to-door delivery use.

- Extensive lating, such as police, taxt or door-to-door delivery use.
   Snow plowing.
   High speed operation with a fully loaded vehicle (Max. GVW).
   Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.
   Check/Regap Spark Plugs every 15,000 miles (24 000 km).

- occurs first.

  Check/Regap Spark Plugs every 15,000 miles (24 000 km).

  SUPER DUTY REAR AXLES ONLY

  The lube charge interval should be shortened to 3000 miles, or 3 months, whichever occurs first, during extended trailer tow operation above 70°F ambient and wide open throttle for extended periods above 45 mph.

  The 3000 mile lube charge interval may be waived if the rear axle has been filled with Ford approved 75W-140 synthetic gear lube meeting material specification ESP-M2C187-A.

  AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

   If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC/HD MANUAL 5-SPEED (\$5-42) TRANSMISSION FLUID and SUPERDUTY REAR AXLE LUBE — Change each 30,000 miles (48 000 km) — if your driving habits frequently include one or more of the following conditions:

Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in

- nllly terrain.

  Operating at maximum loads.

  Towing a trailer or slide-in camper.

  Door-to-door delivery, police or taxi.

  Operating a transmission mounted PTO.

- Door-to-door delivery, police or taxi.
  Operating a transmission mounted PTO.
  EXTREME SERVICE ITEMS
  If your vehicle is operated off-highway, perform the following items every 1,000 miles
  (1 600 km). If your vehicle is operated in mud and/or water, perform the following items delily:
  Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fiftings.
  Inspect front wheel bearings and lubrication.
  Lubricate automatic transmission external controls (Bellcrank system).
  Inspect disc brake system, lube caliper slide rails.
  Inspect drum brake system, hoses and lines.
  Inspect schauss system for leaks, damage or loose parts.
  Lubricate clutch release lever pivot (7.3L and 7.5L).

  CA13379-C

#### MAINTENANCE SCHEDULE G - NORMAL DRIVING CONDITIONS

F-250 HD/350 and Super Duty Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L EFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G - Required for all vehicles

Required for 49 States vehicles and recommended only for California and Canada vehicles.

g — Required for 49 States vehicles and recommended unity for california and Canada vehicles. Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(g) = This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(g)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

|  | NORMAL DRIVING SERVI  |    |    |    |    |    |    |    |    |   |   |   |  |     |          |     |     |     |     | CCUR     |     |     |     |     |          |  |
|--|---|----|----|----|----|----|----|----|----|---|---|---|--|-----|----------|-----|-----|-----|-----|----------|-----|-----|-----|-----|----------|--|
| MAINTENANCE                              | MILES (Thousands)   |    |    |    |    |    |    |    |    |   |   |   |  | 65  | 70       | 75  | 80  | 85  | 90  | 95       | 100 | 105 | 110 | 115 | 120      |  |
|  | LOMETERS (Thousands)  | 8  | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72  | 80  | 88  | 96   | 104 | 112      | 120 | 128 | 136 | 144 | 152      | 160 | 168 | 177 | 184 | 193      |  |
| Other Systems                            |   |    |    | ,  |    |    |    |    |    |   |   |   |  | ,   |          |     |     |     |     |          |     |     |     |     |          |  |
| Change Rear Axle L                       | ube   | L_ |    |    | L  | L_ |    |    |    |   |   |   |  |     | <u> </u> |     | L   | L   | L   | <u> </u> | G   | l   |     |     | <u> </u> |  |
| Check Wheel Lug N                        |   | G  | G  | G  | G  | G  | G  | G  | G  | G   | G   | G   | G  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Check and Lubricate (7.5L)               | Clutch Release Lever  | G  | G  | G  | G  | G  | G  | G  | G  | G   | G   | G   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Check Clutch Fluid F                     | Reservoir Level   | G  | G  | G  | G  | G  | G  | G  | G  | G   | G   | G   | G  |     |          |     |     |     |     |          |     |     |     |     |          |  |
|  | Transfer Case Shift Lever Pivot Control Rod Connecting Pins G G G G G G G G G G G G G G G G G G G |    |    |    |    |    |    |    |    |   |   |   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Lubricate Automatic (Bellcrank System)   | Transmission Linkage  | G  | G  | G  | G  | G  | G  | G  | G  | G   | G   | G   | G  |     |          |     |     |     |     |          |     |     |     |     |          |  |
|  | U-Joints and Slip Yoke  | G  | G  | G  | G  | G  | G  | G  | G  | G   | G G G G G G G G G G G G G G G G G G G   |   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Lubricate Front Axle<br>(F-Super Duty)   | Spindle Pins  |    |    | G  |    |    | G  |    |    | G   |   | G G G Beyond 60,000 miles 96 000 km continue recommended maintenance operations at  |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Rotate Tires                             |   | G  |    | G  |    |    | G  |    |    | G |   |   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect Disc Brake S<br>Rails            | System, Lube Caliper Slide  | Γ  |    | G  |    |    | G  |    |    | G   |   |   | G  Beyond 60,000 miles 96 000 km  continue recommended maintenance operations at |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect Drum Brake                       | System, Hoses and Lines   |    | Π  | G  | Γ  | Г  | G  | Π  | Γ  | G   | G G Beyond 60,000 miles 96 000 km continue recommended maintenance operations at intervals indicated for 0-60,000 miles 96 000 km |   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect and Lubricat                     | te Front Wheel Bearings   |    |    |    | Г  |    | G  |    |    | G G G Beyond 60,000 miles 96 000 km continue recommended maintenance operations at  |   |   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect and Remove<br>Trapped by Exhaust | e any Foreign Material<br>System Shielding  | G  | G  | G  | G  | G  | G  | G  | G  | G   | G   | G G G Beyond 60,000 miles 96 000 km G continue recommended maintenance operations at intervals indicated for 0-60,000 miles 96 000 km |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect Exhaust Sys<br>Loose Parts       | stem for Leaks, Damage or   |    |    |    |    |    | G  |    |    |   |   |   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect Parking Bra<br>Operation         | ke System for Damage and  |    |    |    |    |    | G  |    |    |   |   |   | G  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect Parking Bra<br>(F-Super Duty)    | ke Fluid Level  |    |    | G  |    |    | G  |    |    | G   |   |   | G  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Lubricate Throttle B                     | all Stud  |    |    | Γ  |    |    | G  | Γ  |    |   |   |   | G  | 1   |          |     |     |     |     |          |     |     |     |     |          |  |
| Lubricate Front Driv<br>(4x4) (F250)     | e Axle R.H. Axle Slip Yoke  |    |    |    |    |    | G  |    |    | G G G G G G G G G G   |   |   |  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect Spindle Need                     | dle Bearing Lubrication (4x4)   |    | T  | Γ  | Ī  | Γ  | G  |    |    |   | T   |   | G  | Ì   |          |     |     |     |     |          |     |     |     |     |          |  |
| Inspect Hub Lock L                       | ubrication (4x4)  | Ι  |    |    | Ι  |    | G  |    |    |   |   |   | G  |     |          |     |     |     |     |          |     |     |     |     |          |  |
| Change Transfer Ca                       | ase Oil (4x4)   | Γ  |    |    | Γ  |    | G  |    |    |   | Π   |   | G  | ]   |          |     |     |     |     |          |     |     |     |     |          |  |
| Change Manual Tra<br>(HD M50D/S5-42)     | insmission Oil  | Γ  | T  |    | T  | Γ  |    |    |    |   | Π   |   | G  |     |          |     |     |     |     |          |     |     |     |     |          |  |

Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles 800 km for vehicles equipped with dual rear wheels or equipped for snowplowing). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles 800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

/1 At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost except Canada vehicles

Check means a functional measurement of Systems' operation (performance, leaks or condition of parts). Correct as required NOTE: Refer to page 2 of the Maintenance Schedule Record Log book for "NO COST PCV VALVE REPLACEMENT."

\$ On 5.0L and 5.8L engines because of the new anti-sludge throttle body, the idle speed control air by-pass valve must be removed from the throttle body before cleaning

- UNIQUE DRIVING CONDITIONS

  If your driving habits FREQUENTLY include one or more of the following conditions:

  Short trips of less than 10 miles (16 km) when outside temperatures remain below freezing.

  Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.

  Operating during hot weather in stop-and-go "rush hour" traffic.

  Extensive idling, such as police, taxi or door-to-door delivery use.

  Snow plowing.

High speed operation with a fully loaded vehicle (Max. GVW).
 Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever

Check/Regap Spark Plugs every 15,000 miles (24 000 km)

- SUPER DUTY REAR AXLES ONLY

  The lube change interval should be shortened to 3000 miles, or 3 months, whichever occurs first, during extended trailer tow operation above 70 F ambient and wide open throttle for extended periods above 45 mph.

  The 3000 mile lube change interval may be wa ved if the rear axle has been filled with Ford approved 75W-140 synthetic gear lube meeting material specification ESP-M2C187-A.

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

If operating in severe dust conditions, ask your dealer for proper replacement intervals

AUTOMATIC/HD MANUAL 5-SPEED (S5-42) TRANSMISSION FLUID and SUPERDUTY REAR AXLE LUBE — Change each 30,000 miles (48 000 km) — if your driving habits frequently include one or more of the following conditions:

Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain

Operating at maximum loads.

Towing a trailer or stide in camper.

- Towing a trailer or slide-in camper.
  Door-to-door delivery, police or taxi.
  Operating a transmission mounted PTO.

#### EXTREME SERVICE ITEMS

- EXTREME SERVICE ITEMS
  If your vehicle is operated off-highway, perform the following items every 1,000 miles
  (1 600 km). If your vehicle is operated in mud and or water, perform the following items daily:

   Lubricate tront axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.

   Inspect front wheel bearings and lubrication.

   Lubricate automatic transmission external controls (Bellcrank system)

   Inspect disc brake system, lube caliper slide rails.

   Inspect exhaust system for leaks, damage or loose parts

   Lubricate clutch release lever pivot (7.3L and 7.5L)

  CA15265-A

#### MAINTENANCE SCHEDULE B - NORMAL DRIVING CONDITIONS

E-150/250 and Club Wagon Unleaded Fuel Vehicles with Light Duty Emissions (Under 8,500 lbs. GVWR)

B - Required for all vehicles.

b — Required for 49 States vehicles and recommended only for California and Canada vehicles.
 Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(b) = This item required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(b)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warrants or manufacturer recall liabilities.

| NORMAL DRIVING SERVICE INTERVALS — PE   | RFORM A | T THE | MONT | 'HS O |         |    |      |     |          |       |          |                             |        |         |       |    |
|---|---------|-------|------|-------|---------|----|------|-----|----------|-------|----------|-----------------------------|--------|---------|-------|----|
| MAINTENANCE OPERATION MILES (Thousands  |         | 15    | 22.5 |       | 37.5    |    | 52.5 |     | 67.5     |       | 82.5     |                             | 97.5   |         | 112.5 |    |
| KILOMETERS (Thousands   | ) 12    | 24    | 36   | 48    | 60      | 72 | 84   | 96  | 108      | 120   | 132      | 144                         | 156    | 168     | 181   | 19 |
| Emission Control Systems  |         |       |      |       |         |    |      |     |          |       |          |                             |        |         |       | _  |
| Change Engine Oil and Oil Filter — every 6 months OR  | В       | В     | В    | В     | В       | В  | В    | В   | В        | В     | В        | В                           | В      | В       | В     | Ь  |
| Replace Spark Plugs — Standard  |         |       |      | В     | L       |    |      | ь   |          |       | L        | Ь                           |        |         |       | Lb |
| Replace Coolant — every 36 months OR  |         |       |      | В     | L       | L  |      | В   | L        | l     | <u> </u> | В                           |        |         |       | Ь  |
| *Check Cooling System, Hoses and Clamps   |         |       |      |       |         |    |      | ANN | JALLY    |       |          |                             |        |         | ,     |    |
| Replace Air Cleaner Filter  |         |       |      | В     |         |    |      | b   | L        |       |          | Ь                           |        |         |       | b  |
| Replace Crankcase Emission Filter   |         |       |      | В     |         |    |      | ь   |          |       |          | Ь                           |        |         |       | Ь  |
| \$*Check/Clean Idle Speed Control Air Bypass Valve  |         | L     |      |       | <u></u> | L  |      | (b) | L        |       |          | L                           |        |         |       | (b |
| \$*Check/Clean Throttle Body  |         | L     |      |       | L       | L  |      | (b) |          |       |          |                             |        |         | L     | (b |
| Replace PCV Valve   |         |       |      |       |         |    |      | b/1 |          |       |          | Ĺ                           |        |         |       | t  |
| Replace Ignition Wires  |         |       |      |       |         |    |      | ь   |          |       |          |                             |        |         |       | L  |
| *Check Thermactor Hoses and Clamps #  |         |       |      |       |         |    |      | ۵   |          |       |          |                             |        |         |       | t  |
| Inspect Drive Belt Condition  |         |       |      |       |         |    |      | b   |          |       |          |                             |        |         |       | t  |
| Other Systems   |         |       |      |       | -       |    |      |     |          |       |          |                             |        |         |       |    |
| Change Rear Axle Lube   |         |       |      |       |         |    |      |     |          |       |          |                             |        | В       |       |    |
| Check Wheel Lug Nut Torque*   | В       | В     | В    | В     | В       | В  | В    | В   |          |       |          |                             |        |         |       |    |
| Rotate Tires  | В       | В     |      | В     |         | В  |      | В   |          |       |          |                             |        |         |       |    |
| Check Clutch Reservoir Fluid Level①   | В       | В     | В    | В     | В       | В  | В    | В   |          |       |          |                             |        |         |       |    |
| Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank Syste                     | m) B    | В     | В    | В     | В       | В  | В    | В   |          |       |          |                             |        |         |       |    |
| Inspect and Lubricate Front Wheel Bearings  |         |       |      | В     |         |    |      | В   | 1        |       |          |                             |        |         |       |    |
| Inspect Disc Brake System   |         |       |      | В     |         |    |      | В   | 1        |       |          |                             |        |         |       |    |
| Inspect Drum Brake Systems, Hoses, and Lines  |         | В     |      | В     |         | В  |      | В   | 1        |       |          |                             |        |         |       |    |
| Inspect Exhaust System for Leaks, Damage or Loose Parts   |         | T     |      | В     |         |    |      | В   | 1        |       |          |                             |        |         |       |    |
| Inspect and Remove any Foreign Material Trapped by Exhaust System Shielding                     | В       | В     | В    | В     | В       | В  | В    | В   |          | conti | nue re   | 0,000 i<br>comme<br>at inte | nded n | nainter | nance |    |
| Inspect Parking Brake System for Damage and Operation   |         |       |      | В     |         |    |      | В   | 1        |       |          | at inte<br>00 mile          |        |         |       |    |
| Lubricate Throttle Ball Stud  |         |       |      | В     |         |    |      | В   | 1        |       | - 50,0   | //                          |        | /•      |       |    |
| Lubricate Steering Linkage, Driveshaft U-Joints, and Slip Yoke if Equipped with Grease Fittings | В       | В     | В    | В     | В       | В  | В    | В   | 1        |       |          |                             |        |         |       |    |
| Lubricate Caliper Slide Rails   | 1       | В     |      | В     |         | В  |      | В   | 1        |       |          |                             |        |         |       |    |
| Lubricate Front Axle Spindle Pins   | В       | В     | В    | В     | В       | В  | В    | В   | <u> </u> |       |          |                             |        |         |       |    |

- Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.
- Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation. See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.
- /1 At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles.
- \* Check means a functional measurement of Systems' operation (performance, leaks or conditions of parts). Correct as required

①Commercial Stripped Chassis Only

\$ NOTE: On 5.0L and 5.8L Engines because of the new anti-sludge throttle body, the idle speed control air by-pass valve must be removed from the throttle body before cleaning.

- If your driving habits FREQUENTLY include one or more of the following conditions:

  Short trips of less than 10 miles (16 km) when outside temperatures remain below

- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.

  Operating in severe dust conditions.

  Operating during hot weather in stop-and-go "rush hour' traffic.

  Extensive idling, such as police, taxi or door-to-door delivery service.

  High speed operation with a fully loaded vehicle (max. GVW).

  Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.
- Check/regap SPARK PLUGS every 15,000 miles (24 000 km)
  AIR CLEANER and CRANKCASE EMISSION AIR FILTERS
- Aut Clearlier and Charles are selected and the latest conditions, ask your dealer for proper replacement intervals.

  AUTOMATIC TRANSMISSION FLUID Change each 30,000 miles (48 000 km) if your driving habits frequently include one or more of the following conditions:
- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
  Towing a trailer or slide-in camper.
  Door-to-door delivery, police or taxi.

- EXTREME SERVICE ITEMS
  your vehicle is operated off-highway, perform the following items every 1,000 miles
  600 km). If your vehicle is operated in mud and/or water, perform the following items daily:
  Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft
  U-joints and slip yoke if equipped with fittings.
  Inspect front wheel bearings and lubrication.
  Lubricate automatic transmission external controls (Belicrank system).

- Inspect disc brake system, lube caliper slide rails.

  Inspect drum brake system, hoses and lines.

  Inspect exhaust system for leaks, damage or loose parts.

  Lubricate clutch release lever pivot (7.5L).

CY13380-C

#### MAINTENANCE SCHEDULE G — NORMAL DRIVING CONDITIONS

E-250/350 and Club Wagon Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L EFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G — Required for all vehicles

g — Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(g) = This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(g)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

|  | NORMAL DRIVING SERVI  | CE | NTE | RVA | LS - | - PE | RFC | ЖM | AT 1 | THE | MON | THS | OR  | DIST/ | ANCES | SHO   | NN, W               | HICHE | VER C | CCUR    | S FIR | ST. |     |     |    |
|--|---|----|-----|-----|------|------|-----|----|------|-----|-----|-----|-----|-------|-------|-------|---------------------|-------|-------|---------|-------|-----|-----|-----|----|
| MAINTENANCE  | MILES (Thousands)   |    | 10  |     |      |      |     |    |      |     |     |     | 60  | 65    | 70    | 75    | 80                  | 85    | 90    | 95      | 100   | 105 | 110 | 115 | 12 |
| OPERATION  | KILOMETERS (Thousands)  | 8  | 16  | 24  | 32   | 40   | 48  | 56 | 64   | 72  | 80  | 88  | 96  | 104   | 112   | 120   | 128                 | 136   | 144   | 152     | 160   | 168 | 177 | 184 | 19 |
| Emission Control   | Systems   |    |     |     |      |      |     |    |      |     |     |     |     |       |       |       |                     |       |       |         |       |     |     |     |    |
| Change Engine Oil<br>every 6 months OF                           |   | G  | G   | G   | G    | G    | G   | G  | G    | G   | G   | G   | G   | G     | G     | G     | G                   | G     | G     | G       | G     | G   | G   | G   | G  |
| Replace Spark Plu  | gs  |    |     |     |      |      | G   |    |      |     |     |     | G   |       |       |       |                     |       | G     |         |       |     |     |     | g  |
| Replace Engine Cor   | olant — every 36 months OR  |    |     |     | Г    |      | G   |    |      |     |     |     | G   |       |       |       |                     |       | G     |         |       |     |     |     | [  |
| Check Cooling Sys  | tem, Hoses and Clamps   |    |     |     |      |      |     |    |      |     |     |     |     |       | ANNU  | JALLY |                     |       |       |         |       |     |     |     |    |
| Replace Air Cleane   | er Filter   |    |     |     |      |      | G   |    |      |     |     |     | 9   |       |       |       |                     |       | g     |         |       |     |     |     |    |
| Replace Crankcase  | Ventilation Filter  |    |     |     | Γ    |      | G   |    |      |     |     |     | g   |       |       |       |                     |       | g     |         |       | Г   |     |     | 9  |
| Replace PCV Valve  | 9   |    |     |     |      |      |     |    |      |     |     |     | g/1 |       |       |       |                     |       |       |         |       |     |     |     | 8  |
| Replace Ignition W   | ires  |    |     |     |      |      | Г   |    | П    |     |     |     | g   |       |       |       |                     |       |       |         |       |     |     |     | g  |
| Check Thermactor   | Hoses and Clamps#   |    |     |     |      |      |     |    |      |     |     |     | g   |       |       | Ι     |                     |       | l     |         |       |     |     |     | 1  |
| Check/Clean Idle S   | peed Control Air Bypass Valve                                     |    |     |     | Г    |      |     |    |      |     |     |     | (g) |       |       | Γ     |                     |       |       | Г       |       | Ī   |     |     | (9 |
| *Check/Clean Throt   | tle Body  |    |     |     |      |      |     |    |      |     |     |     | (g) |       |       |       |                     |       |       |         |       |     |     |     | (9 |
| Inspect Drive Belt   | Condition   |    |     | G   |      |      | G   |    |      | G   |     |     | G   |       |       |       |                     |       | G     |         |       |     |     |     | 0  |
| Other Systems  |   |    |     |     |      |      |     |    |      |     |     |     |     |       |       |       |                     |       |       |         |       |     |     |     |    |
| Change Rear Axle   | Lube  |    |     |     |      |      |     |    |      |     |     |     |     |       |       |       |                     |       |       |         | G     |     |     |     | П  |
| Check Wheel Lug  | Nut Torque*   | G  | G   | G   | G    | G    | G   | G  | G    | G   | G   | G   | G   |       | -     |       |                     |       |       |         |       |     |     |     |    |
| Rotate Tires   |   | G  |     | G   | Г    | Г    | G   |    |      | G   |     |     | G   | 1     |       |       |                     |       |       |         |       |     |     |     |    |
| Check Clutch Rese  | ervoir Fluid Level®   | G  | G   | G   | G    | G    | G   | G  | G    | G   | G   | G   | G   | 1     |       |       |                     |       |       |         |       |     |     |     |    |
| Lubricate Automati<br>(Bellcrank System)                         | c Transmission Linkage  | G  | G   | G   | G    | G    | G   | G  | G    | G   | G   | G   | G   |       |       |       |                     |       |       |         |       |     |     |     |    |
| Lubricate Front Axi<br>Linkages, Drivesha<br>Equipped with Fitti | le Spindle Pins, Steering<br>ift U-Joints and Slip Yoke if<br>ngs | G  | G   | G   | G    | G    | G   | G  | G    | G   | G   | G   | G   |       |       |       |                     |       |       |         |       |     |     |     |    |
| Inspect Disc Brake<br>Rails                                      | System, Lube Caliper Slide  | Γ  |     | G   |      |      | G   |    |      | G   |     |     | G   |       |       |       |                     |       |       |         |       |     |     |     |    |
| Inspect Drum Brak  | e Systems, Hoses and Lines  |    |     | G   |      | П    | G   |    |      | G   |     |     | G   | ŀ     |       |       |                     |       |       |         |       |     |     |     |    |
| Inspect and Lubric   | ate Front Wheel Bearings  |    | Π   |     |      |      | G   |    |      |     |     |     | G   |       |       |       |                     |       |       | miles/9 |       |     |     |     |    |
| Inspect Exhaust Sy<br>Loose Parts                                | ystem for Leaks, Damage or  |    |     |     |      |      | G   |    |      |     |     |     | O   |       |       |       | nue rei<br>rvals ir |       |       |         |       |     |     |     |    |
| Inspect and remove<br>by exhaust system                          | e any foreign material trapped<br>shielding                       | G  | G   | G   | G    | G    | G   | G  | G    | G   | G   | G   | G   |       |       |       |                     |       |       |         |       |     |     |     |    |
| Inspect Engine Air<br>(E-350 over 10,000                         | Induction System<br>I lbs. GVWR only)                             |    |     |     |      |      | G   |    |      |     |     |     | G   |       |       |       |                     |       |       |         |       |     |     |     |    |
| Inspect Fan and Fa<br>(E-350 over 10,000                         |   |    |     |     |      |      | G   |    |      |     |     |     | G   |       |       |       |                     |       |       |         |       |     |     |     |    |
| Inspect Parking Bra<br>Operation                                 | ake System for Damage and   |    |     |     |      |      | G   |    |      |     |     |     | G   | ]     |       |       |                     |       |       |         |       |     |     |     |    |
| Lubricate Throttle   | Ball Stud   |    |     |     |      |      | G   |    |      |     |     |     | G   |       |       |       |                     |       |       |         |       |     |     |     |    |
| Change Manual Tra<br>(HD M50D/S5-42)                             | ansmission Oil  |    |     |     | Γ    |      |     |    |      |     |     |     | G   |       |       |       |                     |       |       |         |       |     |     |     |    |

- # Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.
- Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles equipped with dual rear wheels). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.
- // At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.8L and 7.5L engines except California and Canada vehicles.
- \* = Check means a functional measurement of Systems operation (performance, leaks or conditions of parts). Correct as required.

#### Commercial Stripped Chassis

- UNIQUE DRIVING CONDITIONS
  If your driving habits FREQUENTLY include one or more of the following conditions:

  Short trips of less than 10 miles (16 km) when outside temperatures remain below

- Short trips of less than 10 miles (16 km) when outside temperatures remain below freezing.
  Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
  Operating in severe dust conditions.
  Operating during hot weather in stop-and-go "rush hour" traffic.
  Extensive Idling, such as police, taxi or door-to-door delivery service.
  High speed operation with a fully loaded vehicle (Max. GVW).
  Change ENGINE OL AND OLL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

whichever occurs tirst.

Check/regap spark plugs every 15,000 miles (24 000 km).

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

— If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC TRANSMISSION FLUID — Change each 30,000 miles (48 000 km) — if your driving habits frequently include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
  Towing a trailer.
  Door-to-door delivery, police or taxi.
  EXTREME SERVICE ITEMS

If your vehicle is operated off-highway, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.

Inspect front wheel bearings and lubrication.

Lubricate automatic transmission external controls (Bellcrank system).

- Inspect disc brake system, lube caliper slide rails.
   Inspect drum brake system, hoses and lines.
   Inspect exhaust system for leaks, damage or loose parts.
   Lubricate clutch release lever pivot (7.5L).

CA13381-C

#### MAINTENANCE SCHEDULE E - VEHICLES EQUIPPED WITH 7.3L DIESEL ENGINES

|  | State   Column   Co |   |    |    |    |    |    |    |    |    |    |    |     |       |     |     |     |     |     |     |     |     |     |     |     |
|--|--|---|----|----|----|----|----|----|----|----|----|----|-----|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| MAINTENANCE                                  | MILES (Thousands)  | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60  | 65    | 70  | 75  | 80  | 85  | 90  | 95  | 100 | 105 | 110 | 115 | 120 |
| OPERATION KI                                 | LOMETERS (Thousands)   | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96  | 105   | 113 | 121 | 129 | 137 | 145 | 153 | 161 | 169 | 177 | 185 | 193 |
| Emission Control Sy                          | /stems   |   |    |    |    |    |    |    |    |    |    |    |     | •     |     |     |     |     |     |     |     |     |     |     |     |
| Change Engine Oil ar<br>every 6 months or at | nd Replace Oil Filter —<br>Mileage①  | х | х  | х  | х  | ×  | х  | ×  | х  | х  | ×  | х  | х   | х     | x   | x   | х   | x   | х   | x   | X   | x   | х   | х   | х   |
| Check Engine Idle Sp                         | eed (Adjust as Required)   | х |    | ×  |    |    | ×  |    |    | х  |    |    | х   |       |     | х   |     |     | х   |     |     | х   |     |     | х   |
| Check Throttle Opera                         | tion and Idle Return Spring  | х |    | х  |    |    | х  |    |    | х  |    |    | ×   |       |     | х   |     |     | х   |     |     | х   |     |     | х   |
| Inspect, Clean and Lu<br>Fuel Injector Pump  | ubricate Face Cam of   | х |    | х  |    |    | ×  |    |    | х  |    |    | ×   |       |     | х   |     |     | х   |     |     | х   | х   | х   | х   |
| Check Coolant Level<br>Overflow Bottle       | in the Radiator and  |   |    |    |    |    |    |    |    |    |    |    | MON | THLY  |     |     |     |     |     |     |     |     |     |     |     |
|  |  |   |    |    |    |    |    |    |    |    |    |    | ANN | JALLY |     |     |     |     |     |     |     |     |     |     |     |
| Replace Coolant Ever<br>at Mileage           | ry 36 Months or  |   |    |    |    |    | ×  |    |    |    |    |    | ×   |       |     |     |     |     | ×   |     |     |     |     |     | x   |
| Check and Inspect Dr<br>Tension®             | ive Belt Condition and   |   |    |    |    |    | ×  |    |    |    |    |    | ×   |       |     |     |     |     | х   |     |     |     |     |     | х   |
| Replace Air Cleaner I                        | Element2   |   |    |    |    |    | X  |    |    |    |    |    | Х   |       |     |     |     |     | Х   |     |     |     |     |     | Х   |
| Inspect Engine Air Inc                       | duction System   |   |    |    |    |    | Х  |    |    |    |    |    | X   |       |     |     |     |     | Х   |     |     |     |     |     | X   |
| Replace Fuel Filter  2                       |  |   |    |    |    |    |    |    |    |    |    |    | Х   |       |     |     |     |     |     |     |     |     |     |     |     |
| Drain Water from Fue                         | I/Filter Bowl3   | Х | Х  | Х  | Х  | Х  | Х  | Х  | Х  | Х  | Х  | Х  | Х   | Х     | Х   | Х   | Х   | Х   | Х   | Х   | Х   | Х   | Х   | Х   | X   |

<sup>&</sup>quot;Wheel lug nuts must be retightened to proper torque specification at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles with dual rear wheels or vehicles equipped for snowplowing). See your Owner Guide for proper torque specification. Also retighten to proper torque specification at 500 miles/800 km, after any wheel change, or any other time the wheel lug nuts have been loosened.

(i) SEVERE SERVICE OPERATION

When operating your vehicle under any of the following conditions, change engine oil and filter every three months or 2500 miles (4 000 km) whichever occurs first. Use an engine oil conforming to Ford Specifications or the equivalent oil conforming to API service categories of both SF and CD. Do not use oil labeled as only SF or only CD, as they could cause engine damage. The oil should be of the proper viscosity (thickness) as identified on page 29.

- Sustained high speed driving at GVWR during hot weather (over 90°F/32°C).
- Operation in severe dust conditions.
- Trailer towing for long distances (over 1,000 miles/1 600 km).
- Frequent or extended idling (over 10 minutes per hour of normal driving).

@More often if operated in severe service or dust conditions. An instrument panel warning light will glow during normal engine operation when filter replacement is required.

®More frequent intervals may be required dependent on fuel quality and vehicle usage. An instrument panel warning light will glow when servicing is required, or when the ignition key is in the START position.

Every 12 months or at mileage.

- ©For severe service only change fluid every 30,000 miles. The definition of severe service for automatic transmission is as follows:

  The automatic transmission fluid should be changed every 30,000 miles (48 000 km) if your vehicle(s) operate under any of the following conditions:

   Sustained high speed driving during hot weather (+90°F, +32°C).

   Towing a trailer for long distances.

   Accumulating 5,000 miles (8 000 km) or more per month.

   Continuous running service.

(a) Inspect belt and check tension every 5000 miles on ambulance units.

- OHD MANUAL 5-SPEED (S5-42) TRANSMISSION FLUID Change each 30,000 miles (48,000 km) If driving habits frequently include one or more of the following conditions:

   Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.

   Operating at maximum loads.

   Towing a trailer or side in camper.

   Operating a transmission mounted PTO.

- ®For F-Super Duty rear axies, refer to the unique driving conditions noted in Maintenance Schedule G which creates the need for a 30,000 mile lube change interval; note also the extreme service conditions in Schedule G which create the need for a 3,000 mile/3 month lube change interval or the alternative use of 75W-140 rear axie lube meeting material specification ESP-M2C187-A.

#### MAINTENANCE SCHEDULE E - VEHICLES EQUIPPED WITH 7.3L DIESEL ENGINES (Continued)

|  | SERVICE INTERV   | _ |    |       |    |    |    |    | _  |    |    |          |    |     |       | _      |        |       | _      |       |       |        |       |       | _  |
|--|--|---|----|-------|----|----|----|----|----|----|----|----------|----|-----|-------|--------|--------|-------|--------|-------|-------|--------|-------|-------|----|
| MAINTENANCE  | MILES (Thousands)  | 5 | 10 | 15    | 20 | 25 | 30 | 35 | 49 | 45 | 50 | 55       | 60 | 65  | 70    | 75     | 80     | 85    | 90     |       |       | 105    |       |       |    |
| OPERATION  | KILOMETERS (Thousands)   | 8 | 16 | 24    | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88       | 96 | 105 | 113   | 121    | 129    | 137   | 145    | 153   | 161   | 169    | 177   | 185   | 1  |
| Other Systems  |  |   |    |       |    |    |    |    |    |    |    |          |    |     |       |        |        |       |        |       |       |        |       |       |    |
| Change Rear Axle                                     |  |   |    |       |    |    |    |    |    |    |    |          |    |     |       |        |        |       |        |       |       | Х      |       |       | L  |
| Check and Adjust                                     | Wheel Lug Nut Torque*  | Х | ×  | X     | Х  | Х  | Х  | Х  | X  | X  | Х  |          |    |     |       |        |        |       |        |       |       |        |       |       |    |
| inspect Exhaust St<br>Leaks, Breakage,<br>Damage     | ystem/Shields/Joints for<br>Looseness, and Corrosive                                       |   |    |       |    |    | ×  |    |    |    |    |          | x  |     |       |        |        |       |        |       |       |        |       |       |    |
| for Damage or Oil                                    | line Mounted Noise Hardware<br>Fuel Saturation i.e.,; Block<br>overs, Treated Valve Covers |   |    |       |    |    | ×  |    |    |    |    |          | ×  |     |       |        |        |       |        |       |       |        |       |       |    |
| Inspect the Vehicle<br>Mislocated Chassis<br>Shields | for Missing, Damaged, or<br>and Body Mounted Noise   |   |    |       |    |    | х  |    |    |    |    |          | x  |     |       |        |        |       |        |       |       |        |       |       |    |
| Inspect Fan and Fa<br>Over 10,000 lbs. G             | an Shroud (E- and F-350<br>WWR Only)   |   |    | х     |    |    | х  |    |    | ×  |    |          | х  |     |       |        |        |       |        |       |       |        |       |       |    |
| Lubricate Drivesha<br>Equipped with Gre              | ft Slip Yoke and U-Joint if<br>ase Fittings  | х | х  | х     | х  | х  | х  | х  | ×  | ×  | х  | х        | ×  |     |       |        |        |       |        |       |       |        |       |       |    |
| Lubricate Steering with Grease Fitting               | Linkage (Only if Equipped ps)  | x | х  | х     | х  | ×  | х  | х  | х  | х  | х  | х        | х  |     | NOTE  | . Cha  | aka I  | 2020  | -tiono | and I | ubric | ation  | Inton | ala a |    |
| Lubricate Front Ax<br>Only)                          | le Spindle Pins (Econoline   | х | х  | х     | х  | ×  | х  | ×  | ×  | ×  | х  | х        | ×  | ۱   | on-En | nissio | n Item | ns (O | ther S | vstem | s) St | ould ! | Be Co | ntinu | ЮС |
| Inspect and Lubric<br>Shift Linkage (Bell            | ate Automatic Transmission crank System)(1)  | x | ×  | х     | х  | ×  | х  | ×  | х  | x  | х  | х        | ×  |     |       |        |        |       |        |       |       |        |       |       |    |
| Check Clutch Res                                     | ervoir Fluid Level   | Х | X  | Х     | Х  | X  | Х  | X  | Х  | Х  | Х  | X        | X  |     |       |        |        |       |        |       |       |        |       |       |    |
| Lubricate Clutch R                                   | elease Lever Pivots  | Х | х  | X     | Х  | X  | X  | X  | Х  | X  | х  | Х        | X  | 1   |       |        |        |       |        |       |       |        |       |       |    |
| Check Brake Mast                                     | er Cylinder Fluid Level  |   |    |       |    |    | X  |    |    |    |    | Г        | X  | 1   |       |        |        |       |        |       |       |        |       |       |    |
| Inspect Disc Brake<br>Slide Rails                    | System and Lube Caliper  |   |    | ×     |    |    | ×  |    |    | ×  |    |          | ×  | 1   |       |        |        |       |        |       |       |        |       |       |    |
| Inspect Parking Br<br>Operation                      | ake System for Damage and  |   |    | ×     |    |    | х  |    |    | ×  |    |          | ×  |     |       |        |        |       |        |       |       |        |       |       |    |
| Inspect Drum Brail                                   | te Linings, Lines, Hoses   |   |    | X     |    |    | Х  |    |    | Х  |    |          | X  | 1   |       |        |        |       |        |       |       |        |       |       |    |
| Rotate Tires   |  | x |    | ×     |    |    | Х  |    | Ī  | х  |    |          | X  | 1   |       |        |        |       |        |       |       |        |       |       |    |
| Lubricate Throttle                                   | Ball Stud  |   |    | Γ     | Π  |    | Х  | 1  |    | Γ  |    |          | X  | 1   |       |        |        |       |        |       |       |        |       |       |    |
| Inspect and Lubric                                   | ate Front Wheel Bearings   |   |    | Π     |    |    | Х  |    |    |    |    |          | Х  | )   |       |        |        |       |        |       |       |        |       |       |    |
| inspect Hub Lock                                     | Lubrication (4x4)  |   |    | T     |    | Ī  | X  |    |    | Г  |    |          | X  | ]   |       |        |        |       |        |       |       |        |       |       |    |
| Inspect (4x4) Spind                                  | le Needle Bearing Lubrication  |   | Ī  | 1     |    |    | X  | Г  | Ī  |    |    |          | X  | 1   |       |        |        |       |        | _     | _     |        |       |       |    |
| Change Transfer C                                    | Case Oil (4x4)   |   |    | $I^-$ | Г  |    |    | Ī  |    | П  |    | $\Gamma$ | X  | Γ   | Π     | Г      | Π      |       | Г      | П     |       |        |       |       | I  |
| Check Parking Bra<br>Only)                           | ake Fluid Level (F-Super Duty  |   |    | х     |    |    | х  |    |    | х  |    |          | х  |     |       | х      |        |       | х      |       |       | х      |       | х     | I  |
| Change Manual Tr                                     | ansmission Lube(7)   |   | 1  |       | T  | T  | T  | T  | 1  | T  |    | 1        | X  | I   |       | T      |        | Γ     | Г      | T     |       |        |       |       | T  |

"Wheel lug nuts must be retightened to proper torque specification at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles with dual rear wheels or vehicles equipped for snowplowing). See your Owner Guide for proper torque specification. Also retighten to proper torque specification at 500 miles/800 km, after any wheel change, or any other time the wheel lug nuts have been loosened.

Change, or any other time the wheel in the properties of the following conditions, change engine oil and filter every three months or 2500 miles (4 000 km) whichever occurs first. Use an engine oil conforming to Ford Specifications or the equivalent oil conforming to API service categories of both SF and CD. Do not use oil labeled as only SF or only CD, as they could cause engine damage. The oil should be of the proper viscosity (thickness) as identified on page 29.

- Sustained high speed driving at GVWR during hot weather (over 90°F/32°C).
- Operation in severe dust conditions.
- Trailer towing for long distances (over 1,000 miles/1 600 km).
- Frequent or extended idling (over 10 minutes per hour of normal driving).
- More often if operated in severe service or dust conditions. An instrument panel warning light will glow during normal engine operation when filter replacement is required.
- More frequent intervals may be required dependent on fuel quality and vehicle usage. An instrument panel warning light will glow when servicing is required, or when the ignition key is in the START position.

Every 12 months or at mileage.

- (a) For severe service only change fluid every 30,000 miles. The definition of severe service for automatic transmission is as follows:

  The automatic transmission fluid should be changed every 30,000 miles (48 000 km) if your vehicle(s) operate under any of the following conditions:

   Sustained high speed driving during hot weather (+90°F, +32°C).

   Towing a trailer for long distances.

   Accumulating 5,000 miles (8 000 km) or more per month.

   Continuous running service.

- lnspect belt and check tension every 5000 miles on ambulance units.
- © HD Manual 5-speed (S5-42) Transmission Fluid Change each 30,000 miles (48,000 km) if driving habits frequently include one or more of the following conditions:

   Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.

   Operating at maximum loads.

   Towing a trailer or silde in camper.

   Operating a transmission mounted PTO.

- ®For F-Super Duty rear axies, refer to the unique driving conditions noted in maintenance Schedule G which creates the need for a 30,000 mile lube change interval; note also the extreme service conditions in Schedule G which create the need for a 3,000 mile/3 month lube change interval or the alternative use of 75W-140 rear axie lube meeting material specification ESP-M2C187-A.
  CA15266-A

#### **OWNER MAINTENANCE CHECKS**

Listed below are vehicle maintenance checks and inspections that should be performed by the owner or qualified service technician at the indicated intervals. The Owner's Guide contains supporting specifications and service information.

Any adverse conditions should be brought to the attention of the dealer or qualified service technician as soon as possible.

These Owner Maintenance checks are generally not covered by warranties and the owner may be charged for labor, parts and lubricants used.

#### When an Owner Stops for Fuel:

- · Check the engine oil level.
- Check the windshield washer fluid level.
- · Look for low or under-inflated tires.

### While Operating the Vehicle:

- Note any changes in the sound of the exhaust or any smell of exhaust fumes in the vehicle.
- Check for vibrations in the steering wheel. Notice any increased steering effort or looseness in the steering wheel, or change in its straight ahead position.
- Notice if the vehicle constantly turns slightly or "pulls" to one side when traveling on smooth, level road.
- When stopping, listen and check for strange sounds, pulling to one side, increased brake pedal travel or "hard" to push brake pedal.
- If any slipping or changes in the operation of the transmission occurs, check the transmission fluid level.
- Check automatic transmission PARK function.
- Check parking brake.

#### At Least Monthly:

- Check and adjust tire pressure (cold).
- Check coolant level in the coolant recovery reservoir.
- Check operation of lights, horn, turn signals, windshield wipers and washers, and hazard warning flasher.
- Check for fluid leaks by inspecting the surface beneath the vehicle for oil, coolant, or other fluid drips. Clean water from the air conditioning system is normal.

CY3365-2B

#### **MAINTENANCE** (Continued)

#### **OWNER MAINTENANCE CHECKS (Cont'd.)**

#### At Least Twice a Year (i.e., Every Spring and Fall):

- Check power steering reservoir fluid level.
- Check radiator, heater and air-conditioning hoses for leaks or damage.
- Check for worn tires.
- Clean body and door drain holes.
- Flush complete underside of vehicle.
- Inspect underbody components for damage.
- Check exhaust system for leaks or damage.

NOTE: It is normal for a certain amount of moisture and staining to be present around the muffler seams. The presence of soot, light surface rust or moisture does not indicate a faulty muffler.

- Check parking brake system.
- · Check headlamp alignment.
- Check seat and shoulder belt webbing, buckles and release mechanisms.
- Inspect seat back latches for proper operation.
- Check air pressure in spare tire.

#### At Least Once a Year:

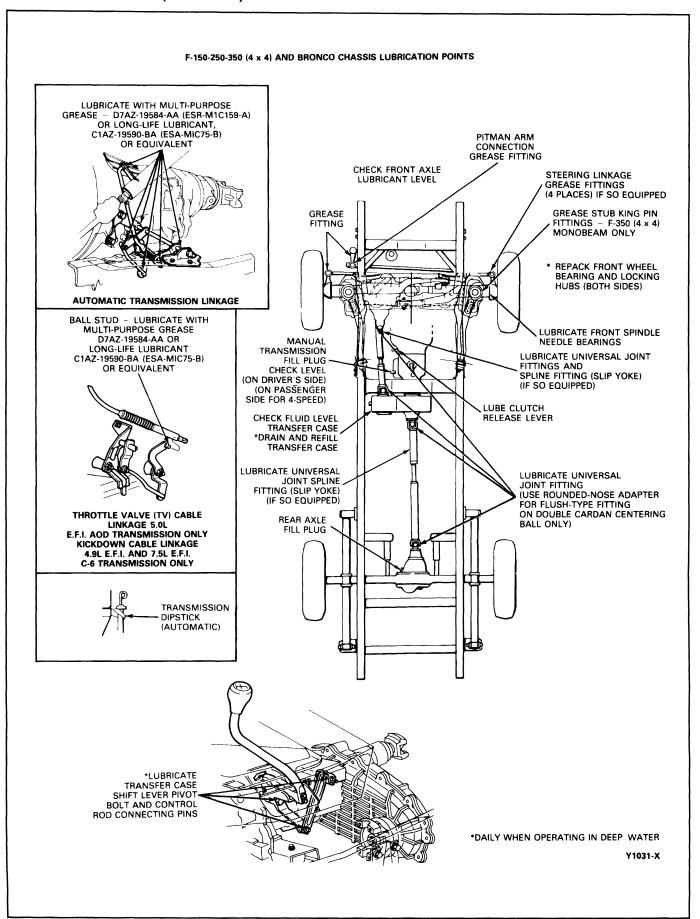
- Lubricate door hinges and checks and hood hinges.
- Lubricate door, hood and deck locks, and latches, including swing-away spare tire carrier latch and striker.
- Lubricate door rubber weatherstrips.
- Inspect and lubricate automatic transmission linkage and controls.
- Clean battery and terminals, check electrolyte level on low maintenance (auxiliary and replacement) batteries.
- Check rear axle fluid levels.

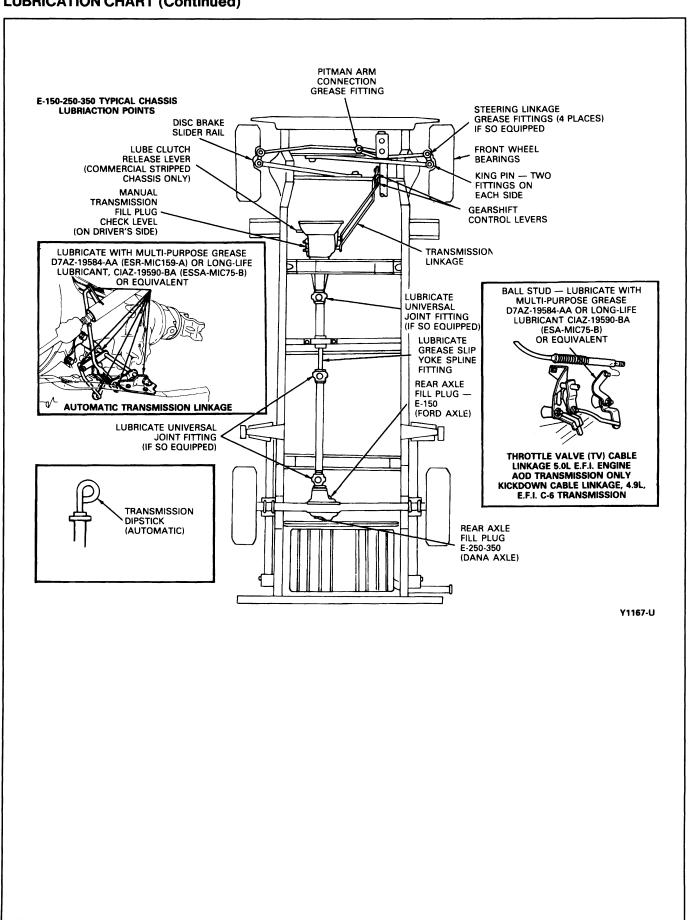
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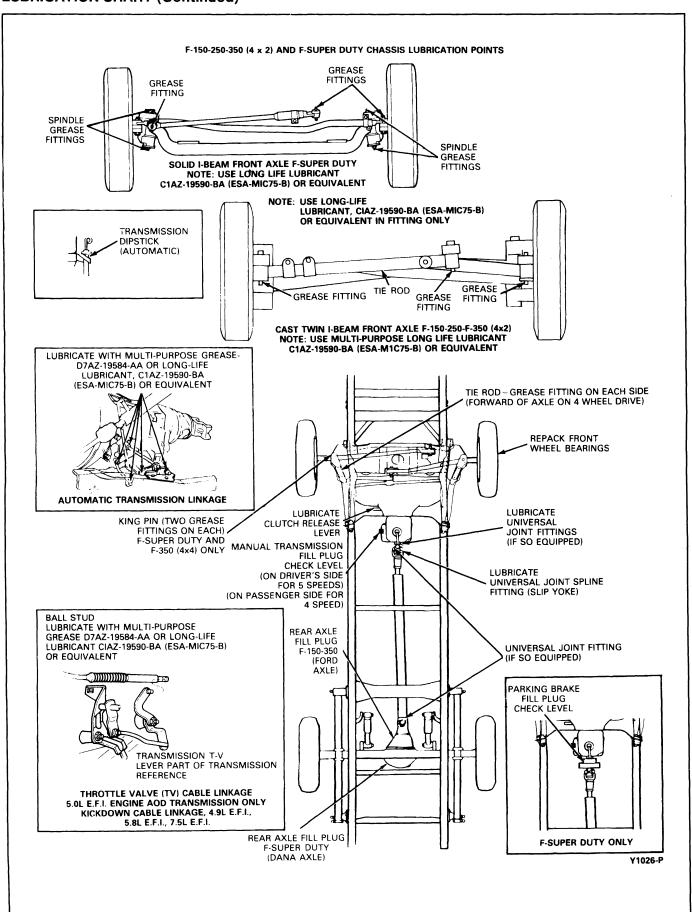
#### **LUBRICATION CHART**

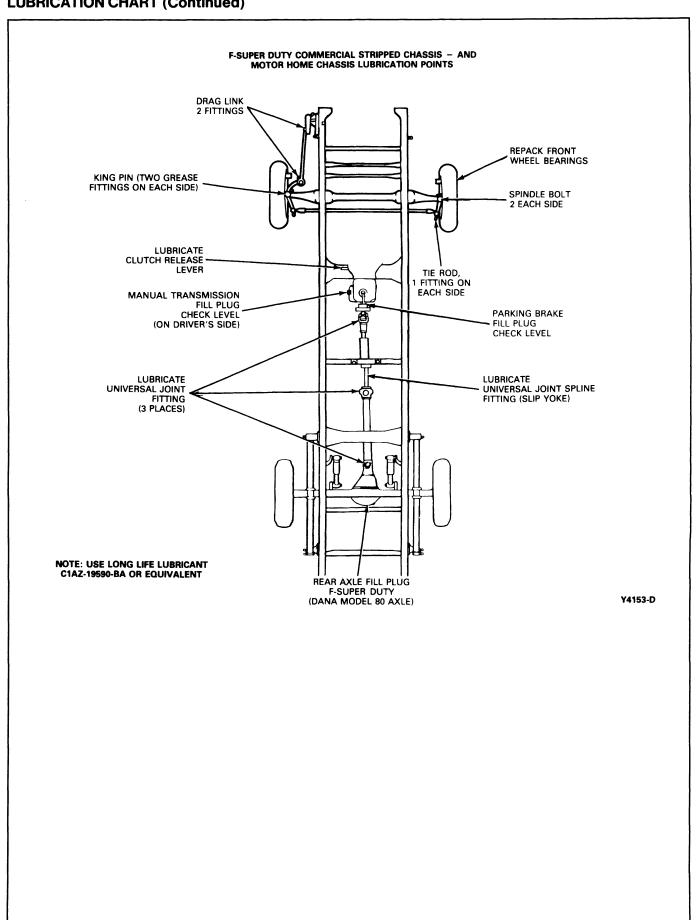
Important lubrication points for typical chassis and engines are shown in the following illustrations. Vehicles with optional equipment may have slightly different or additional lubrication points. When special equipment or accessories are installed on the truck, consult the manufacturer's literature for lubrication procedures. A table of recommended lubricants is included at the end of this Section.

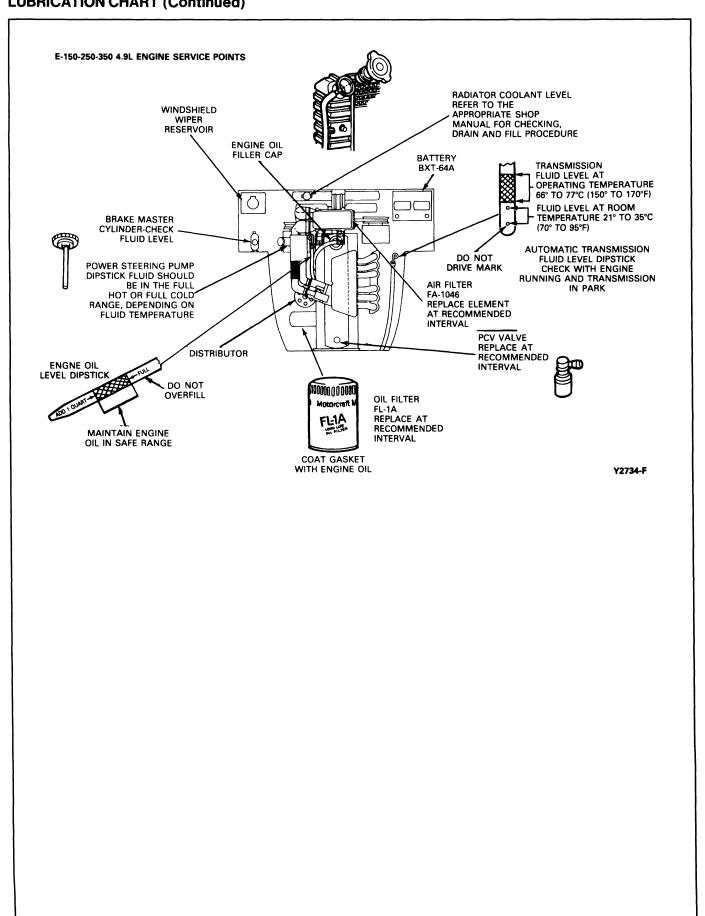
WARNING: THE AMERICAN PETROLEUM INSTITUTE (API) HAS ANNOUNCED THAT CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. THE EFFECTS OF USED MOTOR OIL ON HUMANS HAS NOT BEEN ESTABLISHED. IT IS RECOMMENDED, HOWEVER, THAT AS A PRECAUTIONARY MEASURE, HUMANS PROTECT THEIR SKIN BY WASHING WITH SOAP AND WATER AFTER COMING IN CONTACT WITH USED MOTOR OIL.

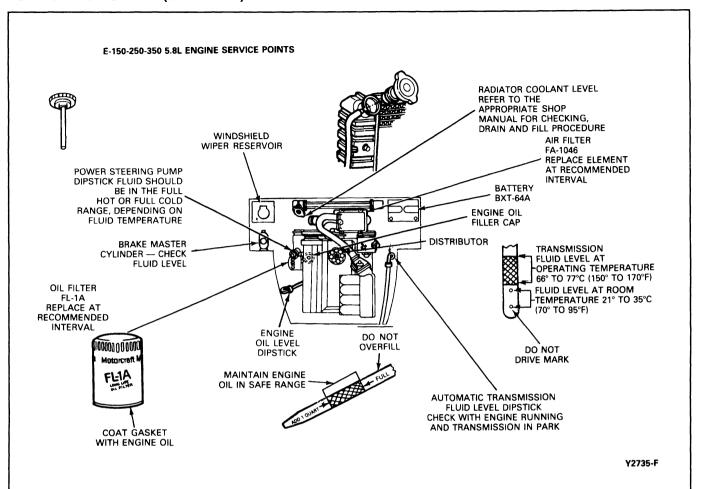


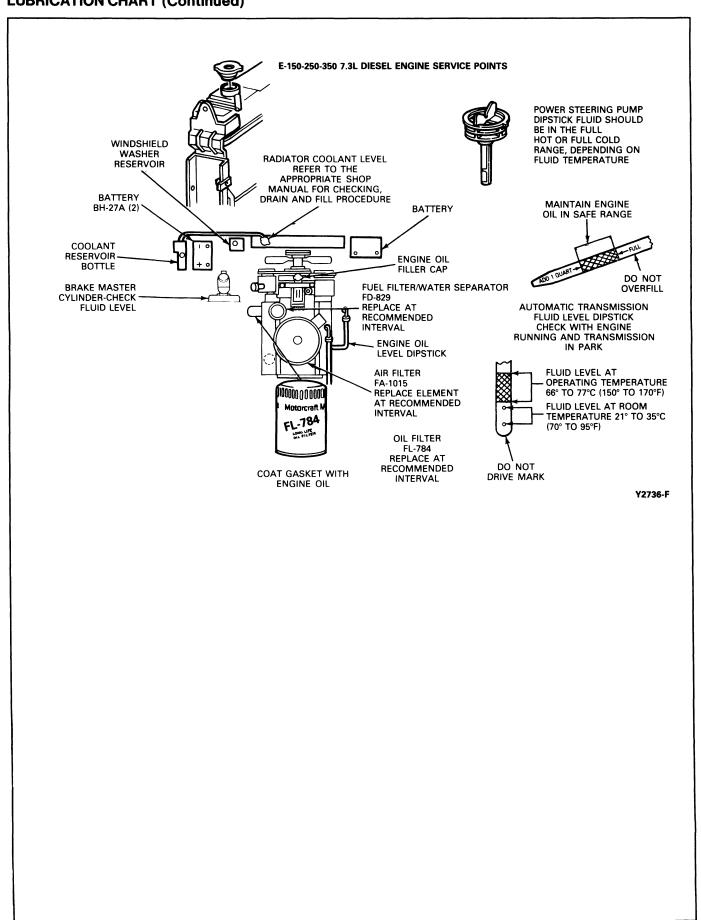


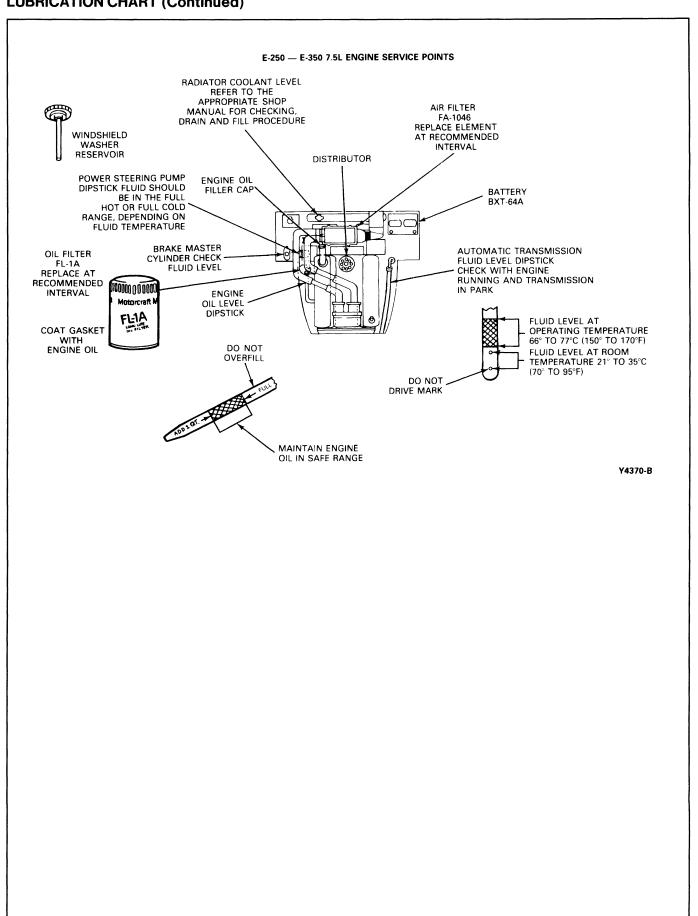


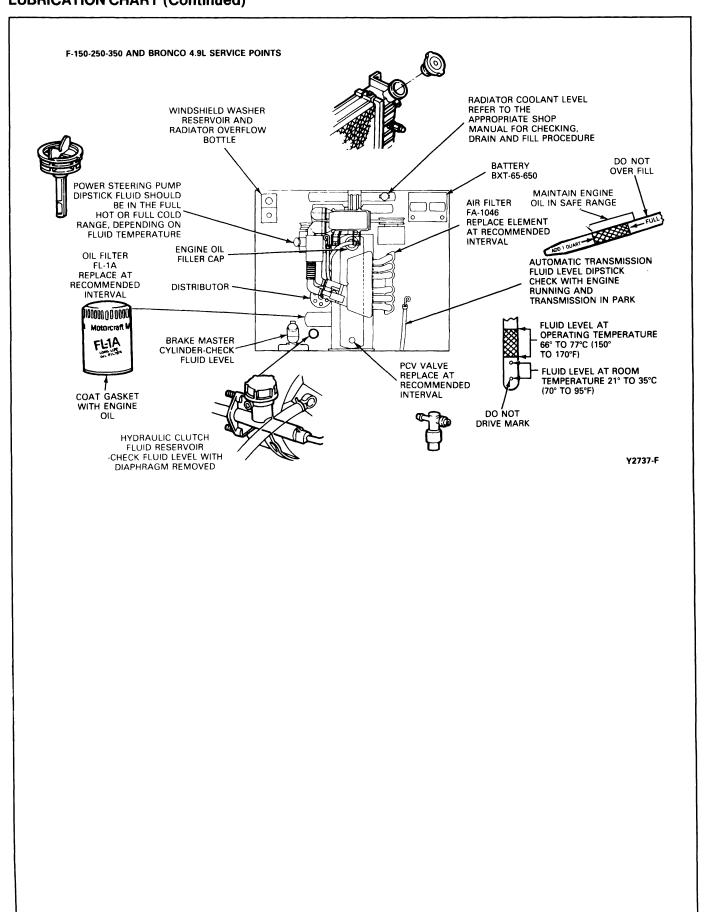


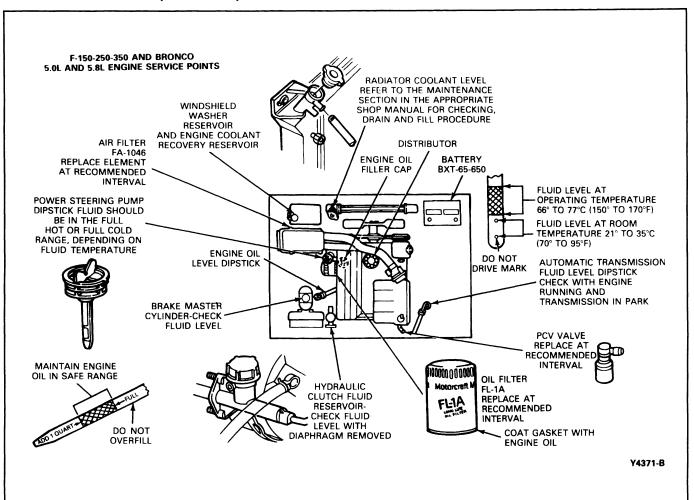


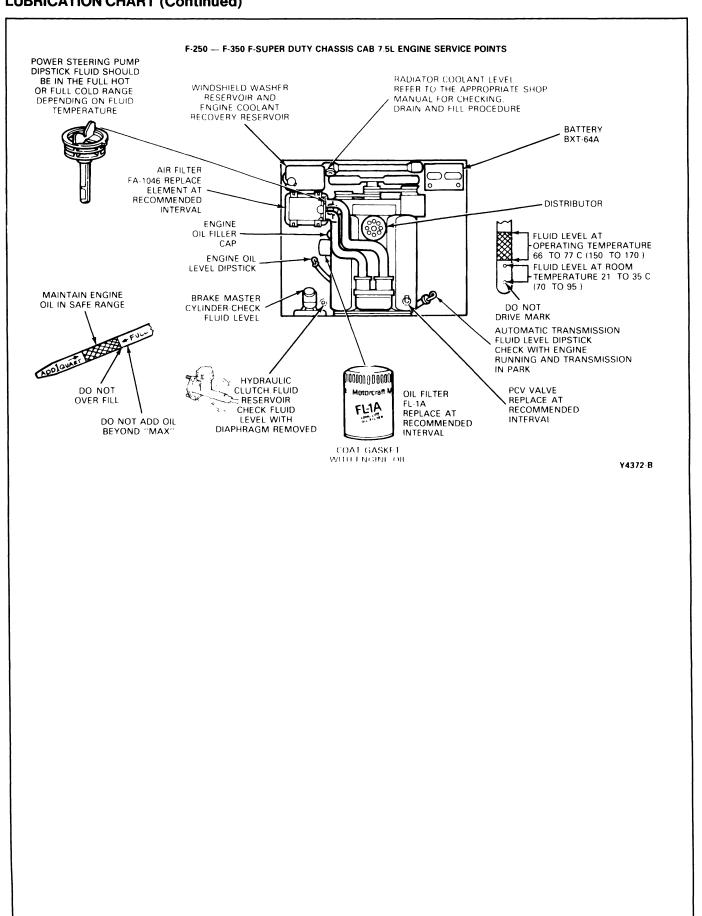


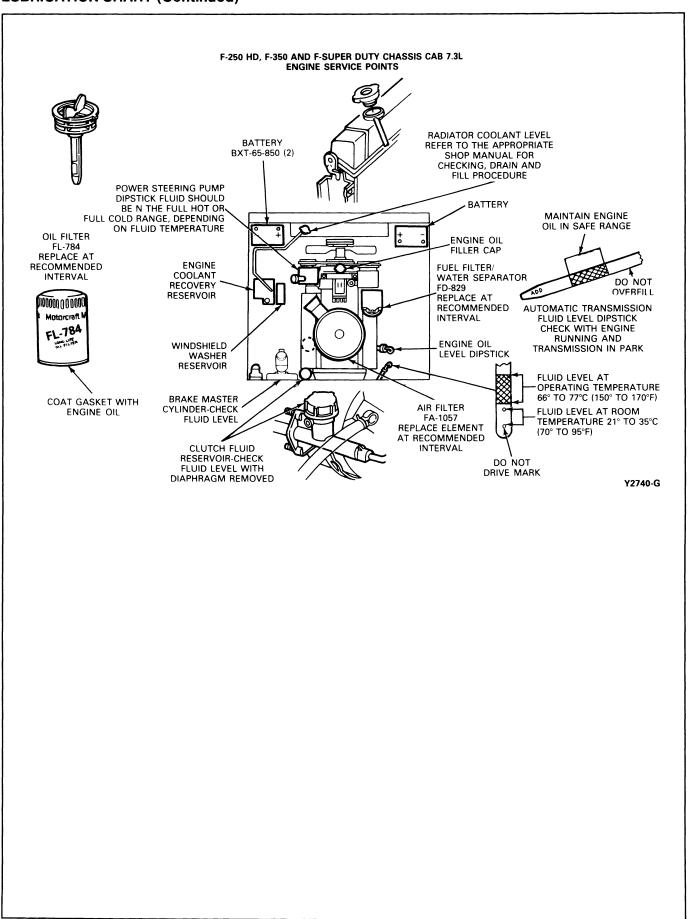












#### **SPECIFICATIONS**

#### LUBRICANT SPECIFICATIONS — E-150 — E-250 — E-350, F-150 — F-250 — F-350, F-SUPER DUTY AND BRONCO

| Item  | Ford Part Name  | Ford Part Number   | Ford Specification                               |
|---|---|--|--|
| Windshield Washer Reservoir   | Ultra-Clear   | C9AZ-19550-AA or BA  | ESR-M17P5-A                                      |
|   | Windshield Washer Solvent   |  |  |
| Body Hinges, Latches, Door Striker Plates and Rotor,<br>Seat Tracks, Door Tracks and Checks, Hood Latch and<br>Auxiliary Latch, Spare Tire Carrier Latch  | Multi-Purpose Grease  | D7AZ-19584-AA  | ESR-M1C159-A                                     |
| Lock Cylinders, Outside Spare Tire Lock   | Lock Lubricant  | D8AZ-19587-AA  | ESB-M2C20-A                                      |
| Front Axle Spindle Pins, Front and Rear Spring Shackle<br>Pins, Steering Column U-Joints, Clutch Linkage Fittings,<br>Universal Joints, Joints with Zerk Fittings, and Slip Yoke<br>Pivots, Parking Brake Linkage Pivots and Clevises,<br>Transmission Control Linkage Pivots | Long-Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| Front Wheel Bearings and Rear Wheel Bearings Brake and Clutch Pedal Shaft   | Long-Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| 4x4 Front Drive Axle, U-Joints, Wheel Bearings and Spindle Needle Bearings  | High Temperature 4x4 Front Axle and Wheel Bearing Grease  | E8TZ-19590-A   | ESA-M1C98-A                                      |
| Power Steering Reservoir  | Premium Power Steering Fluid  | XT-1-QF or<br>E6AZ-19582-AA  | ESW-M2C33-F                                      |
| Clutch Release Lever at Pivots  | Long-Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| Engine Oil — All Gasoline Engines   | Motorcraft Motor Oil<br>5W30 and<br>10W40 Super Premium<br>10W30 Super Premium<br>and 20W40 Premium<br>SAE-30 and<br>15W40 Super Duty | XO-5W30-QSP<br>XO-10W40-QP<br>XO-10W30-QSP<br>XO-20W40-QP<br>XO-30-QSD<br>XO-15W40-QSD | ESE-M2C153-E<br>and API SG/CC,<br>SG/CD or SG/CC |
| Engine Oil — Diesel② (Consult respective engine owners guide for recommendations)   | Motorcraft Motor Oil<br>15W40 Super Duty<br>SAE-30 Super Duty   | XO-15W40-QSD<br>XO-30-QSD  | API SG/CE or<br>SG/CD or<br>ESE-M2C153-E         |
| Engine Oil Filter — Diesel (7.3L)   | Oil Filter  | E3TZ-6731-A (FL-784)   | _  |
| Engine Oil Filter — Gasoline  | Motorcraft Long Life<br>Oil Filter  | D9AZ-6731-A (FL-1A)  | ES-E1ZE-6714-AA                                  |
| C6, E4OD and AOD Automatic Transmission   | Motorcraft MERCON®<br>Multi-Purpose Automatic<br>Transmission Fluid   | XT-2-QDX   | MERCON®  |
| Accelerator Control Kickdown (Automatic 6 Cyl.)   | Long-Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| Speedometer, Parking Brake Cable  | Speedometer Cable Lubricant   | D2AZ-19581-A   | ESF-M1C60-A                                      |
| Steering Linkage — Lubricate only where equipped with grease fittings   | Long-Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| Accelerator Linkage — Ball Socket   | Long-Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| Ford Axles (Conventional and Limited-Slip) 3  | Hypoid Gear Lubricant   | E0AZ-19580-AA  | ESP-M2C154-A                                     |
| Transfer Case — Four-Wheel Drive  | Motorcraft MERCON®<br>Multi-Purpose Automatic<br>Transmission Fluid   | XT-2-QDX   | MERCON®  |
| Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins  | Long Life Lubricant   | C1AZ-19590-BA  | ESA-MIC75-B                                      |
| Front and/or Rear Dana Axles and Dana Limited Slip Rear Axles ①   | Hypoid Gear Lubricant   | C6AZ-19580-E   | ESW-M2C105-A                                     |
| 4-Speed Manual Transmission — Warner T18®   | Manual Transmission Lube  | D8DZ-19C547-A  | ESP-M2C83-C                                      |
| Release Bearing for Clutches with Concentric Slave Cylinders  | Long Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| Release Bearing for Conventional Systems  | Long Life Lubricant   | C1AZ-19590-BA  | ESA-M1C75-B                                      |
| 5-Speed Manual Overdrive Transmission — Mazda   | Motorcraft MERCON®<br>Multi-Purpose Automatic<br>Transmission Fluid   | XT-2-QDX   | MERCON®  |

Requires 6.5 pints.

CY4689-A

Add 4 oz. of Friction Modifier C8AZ-19B546-A (EST-M2C118-A or equivalent) to refill Dana limited slip axles.

② For arctic winter operation below -25°C (-10°F) but not above -7°C (20°F), use engine oil SAE 5W-30 SG/CD or SG/CE.
③ For Ford design rear axles: Add 4 oz. of Friction Modifier C8AZ-19B546-A (EST-M2C118-A) for complete refill of 8.8 inch ring gear limited slip rear axles. For F-250, F-350 with 10.25 inch ring gear limited slip rear axles add 8 oz. of Friction Modifier C8AZ-19B546-A (EST-M2C118-A).

#### **SPECIFICATIONS (Continued)**

F-350, F-150 -- F-250 -- F-350, F-SUPER DUTY AND BRONCO (Cont'd.)

| ltem   | Ford Part<br>Name   | Ford Part<br>Number | Ford<br>Specification<br>MERCON* |  |
|--|---|---------------------|----------------------------------|--|
| 5-Speed Manual Overdrive Transmission ZF(S5-42)①   | Motorcraft MERCON <sup>®</sup> Multi-Purpose Automatic Transmission Fluid | XT-2-QDX            |                                  |  |
| Automatic Transmission Shift Linkage   | Multi-Purpose Grease  | D7AZ-19584-AA       | ESR-M1C159-A                     |  |
| Transmission Throttle Valve (TV) Lever — AOD Only Transmission Kickdown Lever C6 (EFI Engines)   | Long-Life Lubricant   | C1AZ-19590-BA       | ESA-M1C75-B                      |  |
| Disc Brake, Caliper Rails  | Disc Brake Caliper<br>Slide Grease  | D7AZ-19590-A        | ESA-M1C172-A                     |  |
| F-Super Duty Parking Brake   | Motorcraft MERCON <sup>®</sup> Multi-Purpose Automatic Transmission Fluid | XT-2-QDX            | MERCON*                          |  |
| Hydraulic Brake Master Cylinder —<br>Hydraulic Clutch Master Cylinder②   | Heavy-Duty Brake Fluid  | C6AZ-19542-AA or BA | ESA-M6C25-A                      |  |
| Brake and Clutch Pedal Pivots and Clevises   | Engine Oil SAE-10W  | _                   | ESE-M2C153-E<br>API-SG           |  |
| Manual Locking Hubs ON 4x4   | Steering Gear Grease  | C3AZ-19578-A        | ESW-M1C87-A                      |  |
| Driveshaft, Universal Joints (if equipped with fitting),<br>Slip Yoke and Spring Stud Shackles Except Stripped Chassis<br>and Motor Home Chassis | Long-Life<br>Lubricant  | C1AZ-19590-BA       | ESA-M1C75-B                      |  |
| Driveshaft, Universal Joints and Slip Yoke<br>F-Super Duty Stripped Chassis and Motor Home Chassis   | High Temperature Grease<br>NLGI, No. 2                                    | -                   | ESL-M1C173-A                     |  |
| Exhaust Control Valve  | Rust Penetrant and Inhibitor  | D7AZ-19A501-AA      | ESR-M99C56-A                     |  |
| Engine Coolant   | Premium Cooling System Fluid  | E2FZ-19549-AA       | ESE-M97B44-A                     |  |
| Door Weatherstrips   | Silicone Lubricant  | C0AZ-19553-AA       | ESR-M13P4-A                      |  |
| Driveshaft, Slip Yoke, Double Cardan<br>Joint Center Ball  | Long-Life<br>Lubricant  | C1AZ-19590-BA       | ESA-M1C75-B                      |  |
| Automatic Locking Hubs — 4x4   | Automatic Hublock<br>Grease   | E1TZ-19590-A        | ESL-M1C193-A                     |  |

①Synthetic MERCON (E6AZ-19582-B) should be considered when operating under the following extreme conditions:

— Extensive idle time with transmission temperatures below -20°F (-29°C).

— Operating at maximum GCW (F-Super Duty) in hilly terrain with temperatures above 100°F (38°C).

CY4690-A

<sup>-</sup> Continuous (30 minutes) PTO operations.

②As the clutch disc wears, the fluid level in the reservoir will rise. Fluid level above the "step" is an indication of disc wear, NOT overfill.

#### **GROUP**

# ENGINE 03

| SECTION TITLE                      | PAGE     | SECTION TITLE                   | PAGE    |
|------------------------------------|----------|---------------------------------|---------|
| AIR CLEANERS                       |          |                                 |         |
| ENGINE, 4.9L SIX CYLINDER          |          | ENGINE                          | 03-04A- |
| ENGINE, 5.0L AND 5.8L              | 03-01B-1 | FUEL CHARGING AND CONTROLS—7.5L |         |
| ENGINE, 7.3L—DIESEL                | 03-01D-1 | ENGINE                          | 03-04C- |
| ENGINE, 7.5LL                      | 03-01C-1 | FUEL SYSTEM GENERAL             |         |
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#### VEHICLE APPLICATION

All Light Truck Vehicles Equipped with 4.9L, 5.0L, 5.8L or 7.5L Gasoline Engines

#### DESCRIPTION

This section covers various engine tests, adjustments, service procedures and cleaning/inspection procedures. Engine assembly and service specifications appear at the end of the appropriate engine section.

For engine removal, disassembly, assembly, installation, adjustment procedures and specifications, refer to the appropriate engine section.

These engines incorporate a closed-type crankcase ventilation system and exhaust emission control system. All engine / emission control systems are covered in the Engine / Emissions Diagnosis\* manual.

To maintain the required exhaust emission levels, the fuel system, ignition system and engine must be kept in good operating condition and meet recommended adjustment specifications.

When performing tests, adjustment or service to the engine, system or fuel ignition system, it is essential to follow the procedures and specifications in the appropriate repair group in this manual, and in the Engine / Emissions Diagnosis\* manual.

Before replacing damaged or worn engine components such as the crankshaft, cylinder heads, valve guides, valves, camshafts or cylinder block, ensure that part(s) is not serviceable.

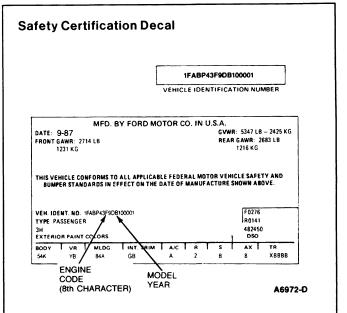
WARNING: TO AVOID THE POSSIBILITY OF PERSONAL INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS FIRST BEEN EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

#### **Exhaust Emission Control System**

Operation, removal, installation and required maintenance of the exhaust emission control devices used on these engines are covered in the Engine / Emissions Diagnosis\* manual.

#### **Engine Identification**

For quick engine identification, refer to the Safety Certification Decal. The decal is mounted on the LH front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage; for instance, engine displacement and model year. Engine decal information is located in the appropriate engine section.



#### **Emission Calibration Label**

The emission calibration number label is located on the LH side door or LH door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

#### **Engine Emission Calibration Number Label**



Always refer to these labels when replacement parts are required or when checking engine calibrations. Engine parts often differ within a CID family. Verification of identification codes will ensure that the proper parts are obtained. The codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application.

#### **DIAGNOSIS AND TESTING**

#### Positive Closed-Type Crankcase Ventilation System

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the crankcase ventilation system and making an air by-pass or idle speed adjustment. The removal of the crankcase ventilation system from the engine will adversely affect the fuel economy and engine ventilation with resultant shortening of engine life. To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, refer to the Engine / Emissions Diagnosis\* manual.

#### **Engine Oil Leaks**

When diagnosing engine oil leaks, it is important that the source and location of the leak be positively identified prior to service. The following procedure has been found to be very effective and requires only a minimum of equipment. Prior to using this procedure, it is important to clean the cylinder block, cylinder head(s), rocker cover(s), oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil.

To perform oil leak diagnosis using Rotunda Oil Leak Detector 112-00001 or equivalent, perform the following procedure.



#### Fluorescent Oil Additive Method

- Clean engine with a suitable solvent to remove all traces of oil.
- Drain engine oil crankcase and refill with recommended oil, premixed with Fluorescent Oil Additive ESE-M99C103-A or equivalent. Use a minimum 14.8ml (1/2 fluid ounce) to a maximum 29.6ml (1 fluid ounce) of fluorescent additive to all engines. If oil is not premixed, fluorescent additive must be added to crankcase first.
- Run engine for 15 minutes. Stop engine and inspect all seal and gasket areas for leaks using Rotunda Oil Leak Detector 112-00001 or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.

- If necessary, pressurize main oil gallery system to locate leaks due to improperly sealed, loose or cocked plugs. If flywheel bolts leak oil, look for sealer on threads.
- 5. Service all leaks as required.

#### **Pressure Method**

#### **Alternative Testing Procedure**

The crankcase can be pressurized to locate oil leaks. The following materials are required to fabricate the tool to be used.

- 1. Air supply and air hose.
- Air pressure gauge that registers pressure in one psi increments.
- Air line shutoff valve.
- Appropriate fittings to attach above parts to oil fill, PCV grommet holes and rocker arm cover tube.
- Appropriate plugs to seal any openings leading to crankcase.
- A solution of liquid detergent and water to be applied with a suitable type applicator such as a squirt bottle or brush.

Fabricate the air supply hose to include the air line shutoff valve and the appropriate adapter to permit the air to enter the engine through the rocker arm cover tube. Fabricate the air pressure gauge to a suitable adapter for installation on the engine at the oil fill opening.

#### **Testing Procedure**

- Open air supply valve until pressure gauge maintains 34 kPa (5 psi).
- Inspect sealed and / or gasketed areas for leaks by applying Snoop Pressure Check or a solution of liquid detergent and water over areas for formation of bubbles, which indicates leakage.

#### Possible Leakage Points

Examine the following areas for oil leakage.

#### Underhood

- Rocker cover sealant
- Intake manifold gaskets
- Cylinder head gaskets
- Oil filter
- Distributor O-ring
- Oil level indicator (dipstick) tube connection
- Oil pressure sending unit
- Cup plugs and / or pipe plugs at end of oil passages

#### Under Engine — With Vehicle on Hoist

- Oil pan gasket
- Oil pan front and rear end seals
- Crankshaft front seal
- Crankshaft rear seal

#### With Transmission and Flywheel Removed

Crankshaft rear seal

Air leakage in area around a crankshaft rear oil seal does not necessarily indicate a rear seal leak. However, if no other cause can be found for oil leakage, it can be assumed that rear seal is the cause of the oil leakage.

- Rear main bearing cap parting line.
- Rear main bearing cap and seals.
- Flywheel mounting bolt holes.
- Rear cup plugs and or pipe plugs at the end of oil passages.

Oil leaks at crimped seams in sheet metal parts and cracks in cast or stamped parts can be detected when pressurizing the crankcase.

NOTE: Light foaming equally around rocker arm cover bolts and crankshaft seals is not detrimental and no corrections are required in such cases.

#### **Compression Test**

#### **Compression Gauge Check**

- Ensure oil in crankcase is of the correct viscosity and at proper level and battery is properly charged. Operate vehicle until engine is at normal operating temperature. Turn off ignition switch, then remove all spark plugs.
- 2. Set throttle plates in wide-open position.
- Install a compression gauge such as Rotunda Compression Tester 059-00009 or equivalent in No. 1 cylinder.
- 4. Install an auxiliary starter switch in starting circuit. With ignition switch in the OFF position, and using auxiliary starter switch, crank engine at least five compression strokes and record highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
- Repeat test on each cylinder cranking the engine approximately the same number of compression strokes.

#### **Test Conclusion**

The indicated compression pressures are considered within specification if the lowest reading cylinder is within 75 percent of the highest. Refer to the Compression Pressure Limit Chart below.

| Maximum<br>PSI | Minimum<br>PSI | Maximum<br>PSI | Minimum<br>PSI | Maximum<br>PSI | Minimum<br>PSI | Maximum<br>PSI | Minimum<br>PSI |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 134            | 101            | 164            | 123            | 194            | 145            | 224            | 168            |
| 136            | 102            | 166            | 124            | 196            | 147            | 226            | 169            |
| 138            | 104            | 168            | 126            | 198            | 148            | 228            | 171            |
| 140            | 105            | 170            | 127            | 200            | 150            | 230            | 172            |
| 142            | 107            | 172            | 129            | 202            | 151            | 232            | 174            |
| 144            | 108            | 174            | 131            | 204            | 153            | 234            | 175            |
| 146            | 110            | 176            | 132            | 206            | 154            | 236            | 177            |
| 148            | 111            | 178            | 133            | 208            | 156            | 238            | 178            |
| 150            | 113            | 180            | 135            | 210            | 157            | 240            | 180            |
| 152            | 114            | 182            | 136            | 212            | 158            | 242            | 181            |
| 154            | 115            | 184            | 138            | 214            | 160            | 244            | 183            |
| 156            | 117            | 186            | 140            | 216            | 162            | 246            | 184            |
| 158            | 118            | 188            | 141            | 218            | 163            | 248            | 186            |
| 160            | 120            | 190            | 142            | 220            | 165            | 250            | 187            |
| 162            | 121            | 192            | 144            | 222            | 166            |                | CA5015         |

If one or more cylinders read low, squirt approximately one tablespoon of heavy SAE 50 weight or equivalent engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

- If compression improves considerably, piston rings are at fault.
- If compression does not improve, valves are sticking or seating poorly.
- If two adjacent cylinders indicate low compression pressures and squirting oil on pistons does not increase compression, cause may be a cylinder head gasket leak between cylinders. Engine oil and/or coolant in cylinders could result from this problem.

It is recommended the Compression Pressure Limit Chart be used when checking cylinder compression so that the lowest reading number is 75 percent of the highest reading.

#### Example

If, after checking the compression pressures in all cylinders, it was found that the highest reading obtained was 196 psi and the lowest pressure reading was 155 psi, the engine is within specification and the compression is considered satisfactory.

#### **Excessive Engine Oil Consumption**

The following diagnostic procedure is intended to be used to determine the source of excessive internal oil consumption.

 Determine what is considered excessive oil consumption, i.e., how many miles are driven per quart of oil? Also, determine owner's driving habits, i.e., sustained high speed operation, towing, extended idle, etc.

Oil usage is normally greater during the first 7,500 miles of service. As mileage increases, oil usage generally decreases. Vehicles in normal service should get at least 900 miles / quart after 7500 miles of service. Vehicles that are subjected to severe duty (high speed driving, towing, high ambient temperature etc.) may result in greater oil usage.

NOTE: Vehicles over 8500 GVWR will consume more oil.

- Verify engine has no external oil leak as outlined under Engine Oil Leaks.
- 3. Perform an oil consumption test:
  - Drain engine oil, remove and replace oil filter and refill with recommended quality and quantity of oil.

- Verify engine has correct engine oil indicator dipstick.
- Run engine for two minutes, then turn engine off. Allow oil to drain into oil pan for additional three minutes (vehicle should be on level surface).
- d. With engine off and vehicle on level surface, remove engine oil dipstick and wipe clean. Fully re-install dipstick, then remove it again. Note where the oil level is on graphic, stamped on dipstick. Oil level should be between top of cross hatch area and "F" in Full. Using a file, scribe a notch on edge of dipstick, indicating the actual full level.
- e. Record vehicle's mileage.
- f. Determine amount of miles driven to consume one quart of oil. If unacceptable, proceed to step 4.
- Check PCV valve system. Ensure system is not plugged.
- Check for plugged oil drain back holes in cylinder head(s), and cylinder block.
- 6. If after performing the above, the condition still exist, proceed to step 7.
- Perform a cylinder compression test as outlined, and/or perform a cylinder leak detection test with Tester 014-00705. This can be helpful in determining source of oil consumption i.e., valves, piston rings etc.
- Check valve guides for excessive guide clearance. Replace all valve stem/guide seals after correct valve guide clearance has been verified.
- Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on tip of spark plugs can be a clue to internal oil consumption. If internal oil consumption still persist, proceed as follows:
  - Remove engine from vehicle, place it on an engine work stand. Remove intake manifold(s), cylinder head(s), oil pan and oil pump. Refer to procedure in the appropriate engine section of the Car / Truck Shop Manual.
  - b. Check piston ring clearance, ring gap and ring orientation. Service as required.
  - Check for excessive bearing clearance, Service as required.

NOTE: After checking for worn parts and it is determined parts should be replaced, ensure correct replacement parts are used.

 Perform oil consumption test to confirm oil consumption concern has been resolved.

# Static Engine Off Valve Train Analysis (Rocker Arm Cover Removed)

NOTE: Refer to the appropriate engine section for the Removal and Installation of the engine rocker arm cover.

Check for damaged and / or severely worn parts, for correct assembly, and ensure use of correct parts by proceeding, as follows, with the static engine analysis.

#### **Rocker Arm Assemblies**

- Check for loose mounting bolts, studs and nuts.
- Check for plugged oil feed in the rocker arm or cylinder head.

#### Push Rods (if equipped)

 Check for bent push rods and restriction in oil passage.

#### Valve Springs

Check for broken or damaged parts.

#### Retainer and Keys

 Check for proper seating of keys on valve stem and in retainer.

#### **Positive Rotator and Keys**

 Check for proper seating in the positive rotator, and on valve stem.

#### Valves and Cylinder Head

- Check the cylinder head gasket for proper installation.
- Check for plugged oil drain back holes.
- Check for worn or damaged valve tips.
- Check for missing or damaged guide-mounted valve stem oil seals.
- Check collapsed tappet gap, hydraulic tappet applications.
- Check installed spring height.
- Check for missing or worn valve spring seats, if equipped.

Static checks (engine off) are to be made on the engine prior to the dynamic procedure.

#### **Dynamic Valve Train Analysis**

Start the engine and, while running at idle, check for proper operation of all parts. Check the following:

#### Rocker Arm Assemblies, Individually Mounted

- Check for plugged oil feed in rocker arm or cylinder head.
- Check for proper overhead valve train lubrication.
- Check for plugged oil feed in rocker arm.

#### **Rocker Arm Assemblies**

- Check for plugged oil feeds.
- Check for proper overhead valve train lubrication.

If a condition of insufficient oiling is suspected, accelerate the engine to 1200 rpm  $\pm$  100 rpm with the transmission in NEUTRAL and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arm are well oiled and / or, with the rocker arm cover off, oil splash may overshoot rocker arm. If oiling is insufficient for this condition to occur, check oil passages for blockage.

#### **Push Rods**

- Check for bent push rods and restriction in oil passage.
- Check for proper rotation of push rod (non-roller tappets).

#### **Positive Rotator and Keys**

Check for proper operation of positive rotator.

#### Valves and Cylinder Head

- Check for plugged oil drain back holes.
- Check for missing or damaged valve stem oil seals or guide mounted oil seals.

If a condition of insufficient oiling is suspected, check oil passages for blockage, then accelerate the engine to 1200 rpm with the transmission in NEUTRAL and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arms are well oiled. With the rocker arm cover off, some oil splash may overshoot rocker arm.

#### Camshaft Lobe Lift

Check the lift of each lobe in consecutive order and make a note of the readings.

- Remove valve rocker arm cover(s).
- Remove rocker arm fulcrum bolts, fulcrum and rocker arm.
- Ensure tappet is seated against cam. Install Dial Indicator TOOL-4201-C or equivalent in such a manner as to have ball socket adapter of indicator on top of tappet, or push rod and in same plane as tappet or push rod movement.

# Typical Engine With Pushrods DIAL INDICATOR TOOL 4201-C CUP SHAPED -ADAPTER TOOL 6565-AB A2958-E

- 4. Remove spark plugs.
- Connect an auxiliary starter switch in starting circuit. Crank engine with ignition switch in OFF position. "Bump" crankshaft over until tappet is on base circle of camshaft lobe. At this point, tappet will be in its lowest position. If checking during engine assembly, turn crankshaft using a socket or ratchet.
- Zero dial indicator. Continue to rotate crankshaft slowly until tappet is in fully raised position (highest indicator reading).
- Compare total lift recorded on indicator with specifications.
- To check accuracy of original indicator reading, continue to rotate crankshaft until indicator reads zero.

NOTE: If lift on any lobe is below specified service limits, camshaft and tappet operating on worn lobe(s) must be replaced, as well as any tappet showing pitting or having contact face worn flat or concave. Refer to Camshaft and Hydraulic Lash Adjuster Inspection.

Remove dial indicator and auxiliary starter switch.

CAUTION: After installing rocker arms, do not rotate crankshaft until tappets have had sufficient time to bleed down. To do otherwise may cause serious valve damage. Manually bleeding down will reduce waiting time.

- 10. Install valve rocker arm cover.
- 11. Install spark plugs.

#### Hydraulic Tappet/Lash Adjuster

Hydraulic tappet noise may be caused by any of the following:

- 1. Excessive collapsed tappet gap
- 2. Sticking tappet plunger
- 3. Tappet check valve not functioning properly
- 4. Air in lubrication system
- 5. Leakdown rate too rapid
- 6. Excessive valve guide wear

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts / nuts, incorrect initial adjustment, or wear of tappet face, or worn roller tappets, push rod rocker arm, rocker arm fulcrum or valve tip. With tappet collapsed, check gap between valve tip and rocker to determine if any other valve train parts are damaged, worn or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. The sticking can be corrected by disassembling the tappet and removing the dirt, chips or varnish that are causing the condition.

A tappet check valve that is not functional may be caused by an obstruction such as dirt or chips preventing it from closing when the cam lobe is lifting the tappet, or it may be caused by a broken check valve spring.

Air bubbles in the lubrication system will prevent the tappet from supporting the valve spring load and may be caused by too high or too low an oil level in the oil pan, or by air being drawn into the system through a hole, crack or leaking gasket on the oil pump pickup tube.

If the leakdown time is below the specified time for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, the leakdown rate should be checked and any outside the specification should be replaced.

Assembled tappets can be tested with Hydraulic Tappet Leakdown Tester TOOL-6500-E or equivalent, to check the leakdown rate. The leakdown rate specification is the time in seconds for the plunger to move a specified distance of its travel while under a 22.7 kg (50 lb) load. Test the tappets as follows:

#### **Leakdown Testing**

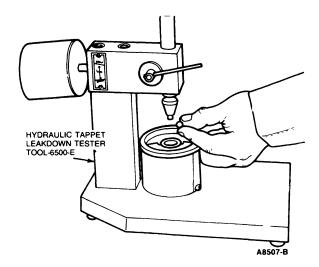
 Disassemble and clean tappet to remove all traces of engine oil.

NOTE: Do not mix parts from different tappets. Parts are select-fitted and are not interchangeable.

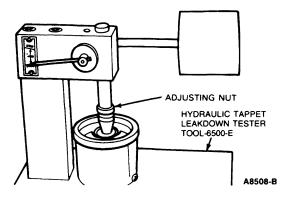
NOTE: Tappets cannot be checked with engine oil in them. Only testing fluid can be used.

 Place tappet in tester, with plunger facing upward. Pour hydraulic tester fluid into cup to a level that will cover tappet assembly. The fluid can be purchased from manufacturer of tester. Using kerosene or any other fluid will not provide an accurate test.

 Place a 7.94mm (5 / 16 inch) steel ball provided with tester in plunger cap.



 Adjust length of ram so that pointer is 1.59mm (1/16 inch) below starting mark when ram contracts tappet plunger, to facilitate timing as pointer passes Start Timing mark.



Use center mark on pointer scale as Stop Timing point instead of original Stop Timing mark at top of scale.

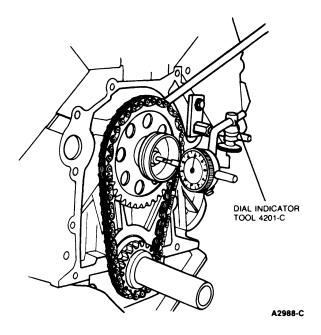
- Work tappet plunger up and down until tappet fills with fluid and all traces of air bubbles have disappeared.
- Allow ram and weight to force tappet plunger downward. Measure exact time it takes for pointer to travel from Start Timing to Stop Timing marks of tester.
- A tappet that is satisfactory must have a leakdown rate (time in seconds) within minimum and maximum limits specified.
- 8. If tappet is not within specification, replace it with a new tappet. If a worn flat tappet is replaced with a new tappet it is recommended that a new camshaft be installed. It is not necessary to disassemble and clean new tappets before testing because oil contained in new tappets is test fluid.

 Remove fluid from cup and bleed fluid from tappet by working plunger up and down. This step will aid in depressing tappet plungers when checking valve clearance.

#### **Camshaft End Play**

CAUTION: Prying against the camshaft gear with the valve train load on the camshaft can break or damage the gear. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, adjust the valve clearance.

 Push camshaft toward rear of engine. Install Dial Indicator TOOL-4201-C or equivalent so indicator point is on camshaft sprocket attaching screw.

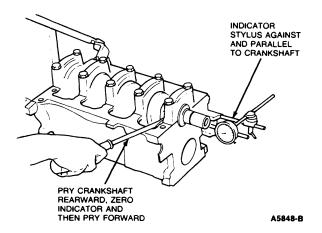


- Zero dial indicator. Pull camshaft forward and release it. Compare dial indicator reading with specifications. If end play is excessive, replace camshaft thrust plate.
- Remove dial indicator.
- After replacing thrust plate, check end play again. If it is still out of specified range, inspect camshaft and cylinder head/cylinder block for excessive wear.

#### Crankshaft End Play

1. Force crankshaft toward rear of engine.

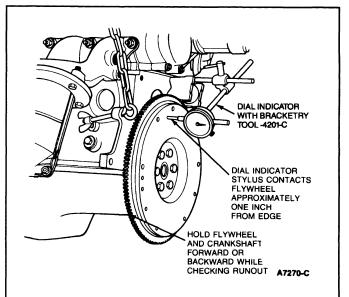
 Install Dial Indicator TOOL-4201-C or equivalent so contact point rests against crankshaft flange and indicator axis is parallel to crankshaft axis.



- Zero dial indicator. Push crankshaft forward and note reading on dial.
- 4. If the end play exceeds the wear limit listed in the specific engine section, replace the thrust bearing. Inspect the crankshaft for damage to the thrust face before installing the new bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If the thrust faces are not damaged or dirty, they probably were not aligned properly. Lubricate and install the thrust bearing and align the faces, following Main Bearing Replacement procedure in the appropriate engine section. Check the crankshaft end play.

#### Flywheel Runout (Manual Transmission)

- 1. Remove spark plugs.
- 2. Install Dial Indicator TOOL-4201-C or equivalent so indicator points rest on face of the flywheel.



- Hold flywheel and crankshaft forward or backward as far as possible to prevent crankshaft end play from being indicated as flywheel runout.
- Set indicator dial on zero mark. Turn flywheel one complete revolution while observing total indicator reading (TIR). If TIR exceeds specification, flywheel and ring gear assembly must be replaced.
- If clutch face runout exceeds specification, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. Replace flywheel or machine crankshaft flywheel mounting face sufficiently to true-up the surface.

#### **OVERHAUL**

#### **Service Limit Specifications**

Service limit specifications are intended to be a guide only, to be used when overhauling or reconditioning an engine or engine component. A determination can be made whether a component is suitable for continued service or should be replaced for extended service while the engine is disassembled.

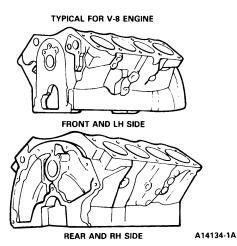
#### **Cylinder Block**

#### **Servicing Sand Holes or Porous Engine Castings**

Porosity or sand hole(s), which will cause oil seepage or leakage, can occur with modern casting processes. A complete inspection of engine and transmission should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), service can be made with Ford Metallic Plastic C6AZ-19554-A (M3D35-A(E)) or equivalent. Do not service cracks with this material. Service with this metallic plastic must be confined to those cast iron engine component surfaces where the inner wall surface is not exposed to engine coolant pressure or oil pressure. For example:

- Cylinder block surfaces extending along the length of the block, upward from the oil pan rail to the cylinder water jacket, but not including machined areas.
- b. Lower rear face of the cylinder block.
- c. Intake manifold casting. Service is not recommended to the intake manifold exhaust crossover section, since temperatures can exceed the recommended temperature limit of 260°C (500°F).
- d. Cylinder front cover on engines using cast iron material.
- e. Cylinder head, along the valve rocker arm cover gasket surface.

The following procedure should be used to service porous areas or sand holes in cast iron.



Clean surface to be serviced by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut hole or porosity to a greater depth than rest of cleaned surface. Solid metal must surround hole. Openings larger than 6.35mm (1/4 inch) should not be serviced using metallic plastic. Openings in excess of 6.35mm (1/4 inch) can be drilled, tapped and plugged using common tools. Clean service area thoroughly. Metallic plastic will not stick to a dirty or oily surface.

- Mix metallic plastic base and hardener as directed on container. Stir thoroughly until uniform.
- Apply service mixture with a suitable clean tool (putty knife, wood spoon, etc.) forcing epoxy into hole or porosity.
- Allow service mixture to harden. This can be accomplished by two methods. Heat cure with a 250-watt lamp placed 254mm (10 inches) from serviced surface, or air-dry for 10-12 hours at temperatures above 10°C (50°F).
- 5. Sand or grind serviced area to blend with general contour of surrounding surface.
- Paint the surface to match the rest of the block.

#### Cylinder Walls, Refinishing

Honing is recommended for refinishing cylinder walls only when no cross-hatch pattern is visible on cylinder walls, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance. After honing, thoroughly clean cylinder bores with a detergent and water solution.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished.

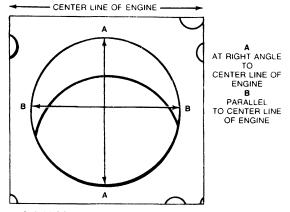
Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation. Hone only the cylinder or cylinders that require refinishing. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance. Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

Refinish the cylinder to within approximately 0.038mm (0.0015 inch) of the required oversize diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained. For the proper use of the refinishing equipment, follow the instructions of the manufacturer. Only experienced personnel should be allowed to perform this work.

Use a motor-driven, spring pressure-type Cylinder Hone Set T73L-6011-A or equivalent, hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 18-38 AA.

When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and SAE No. 20 motor oil. Operate the hone in such a way as to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore. After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly clean with a detergent and water solution and then oil the cylinder walls. Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls.

Refinish cylinders that are deeply scored, out-of-round, and/or taper exceeds specification. If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings, providing the piston clearance is within specification. For specifications, refer to the appropriate engine section.



OUT-OF-ROUND = DIFFERENCE BETWEEN A AND B TAPER = DIFFERENCE BETWEEN THE A MEASURE-MENT AT TOP OF CYLINDER BORE AND THE A MEASUREMENT AT BOTTOM OF CYLINDER BORE.

A2905-B

#### Cleaning

After any cylinder bore service operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean, lint-free cloth. Finally, wipe the bore(s) with a clean cloth dipped in engine oil. If these procedures are not followed, rusting of the cylinder bore(s) may occur.

If the engine is disassembled, thoroughly clean the block with solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages, clean out all the passages. Blow out all passages, then bolt holes, etc., with compressed air. Ensure threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove all deposits. Thoroughly clean the grooves in the crankshaft bearings and bearing retainers.

#### Inspection

After the block has been thoroughly cleaned, check it for cracks. Tiny cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. Do not use rubbing alcohol as a substitute. If cracks are present, the coating will become discolored at the damaged area. Replace the block if it is cracked.

Check all machined surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.

Check the cylinder block for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications listed in the specific engine section, but not to exceed 0.254mm (0.010 inch) stock removal from the original gasket surface.

Replace all plugs that show evidence of leakage. Inspect the cylinder walls for scoring, roughness or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine. Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston-to-cylinder bore clearance.

Inspect the main and connecting rod journals for cracks, scratches, grooves, scores or rough finish. Inspect the crankshaft oil seal surface for nicks, sharp edges, or burrs that might damage the oil seal during installation or cause premature seal wear.

A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL

A7267-B

#### **Core Plugs**

#### Removal and Installation

To remove a large core plug, drill a 12.70mm (1/2 inch) hole in the center of the plug and remove with an Impact Slide Hammer T59L-100-B or T50T-100-A or pry it out with a large drift punch. On a small core plug, drill a 6.35mm (1/4 inch) hole in the center of the plug and pry it out with a small pin punch. Clean and inspect the plug bore.

Prior to installing a core plug, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged, it will be necessary to true the surface by boring for the next specified oversize plug.

Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

Coat the plug and / or bore lightly with an oil-resistant (oil galley) Sealing Compound EOAZ-19554-B or EZAZ-19544-B, or equivalent, and install it following the procedure for cup-type or expansion type below:

#### Cup-Type

Cup-type core plugs are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on cup-type plugs flares outward with the largest diameter of the outer (sealing) edge.

#### **Expansion-Type**

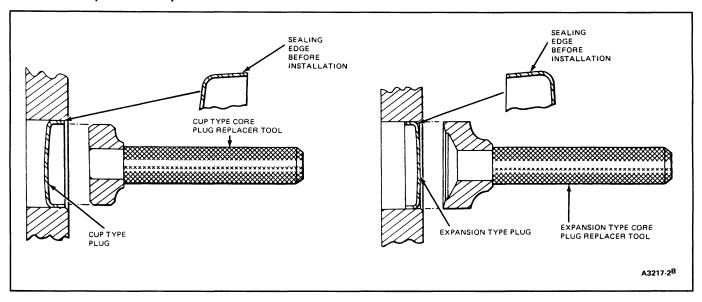
Expansion-type core plugs are installed with the flange edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

CAUTION: It is imperative to push or drive the plug into the machined bore using a properly designed tool. Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage the plug and/or plug bore.

When installed, the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

CAUTION: It is imperative to pull the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blowout.



The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

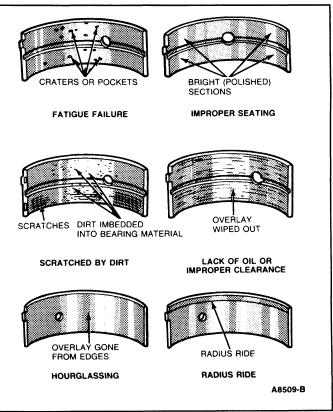
#### Main and Connecting Rod Bearings Cleaning

Bearings that are to be reused should be identified so they can be installed in their original locations.

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air. **Do not scrape gum or varnish deposits from the bearing shells.** 

#### Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in the illustration. The copper lead bearing base may be visible through the bearing overlay. If the base showing is less than 20 percent of the total area, the bearing is not excessively worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage as outlined.



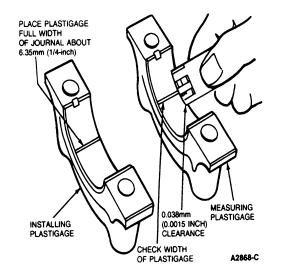
### Fitting Main or Connecting Rod Bearings with Plastigage

 Clean crankshaft journals. Inspect journals and thrust faces for nicks, burrs or roughness that would cause premature bearing wear. When replacing standard bearings with new bearings, it is good practice to fit bearing to minimum specified clearance. If desired clearance cannot be obtained with a standard bearing, try a 0.050mm (0.002 inch) undersize bearing set to obtain proper clearance.

 If fitting main bearing in vehicle, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.

CAUTION: Do not position jack under crankshaft pulley. Crankshaft post damage will result.

- Place a piece of Plastigage D81L-6002-B or equivalent on bearing surface across full width of bearing cup and about 6.35mm (1/4 inch) off center.
- Install cap and tighten bolts to specification. Do not turn crankshaft while Plastigage is in place.
- Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between reading is taper of journals.



- 6. If bearing clearance exceeds the specified limits, try using one of the various combinations of undersize bearings as directed by the accompanying table. Use of any other bearing combination is not recommended. Bearing clearance must be within specified limits. Refer to appropriate section under Specifications, for main and connecting rod bearing clearance limits. If use of these bearing combinations do not bring clearance to the desired limits, refinish the crank journal to .254mm (.010 inch) undersize, and use the appropriate undersize bearing.
- After bearing has been fitted and cleaned apply a light coat of engine oil to journal and bearings. Install bearing cap. Tighten cap bolts to specification.
- 8. Repeat procedure for remaining bearings that require replacement.

| FOR THIS AMOUNT |                     | USE THIS BEARING SIZE       |            |          |            |  |
|-----------------|---------------------|-----------------------------|------------|----------|------------|--|
|                 | EARING<br>CE EXCESS | UPPER BEARING LOWER BEARING |            | BEARING  |            |  |
| mm              | Inch                | mm                          | Inch       | mm       | Inch       |  |
| 0.0-0.013       | 0.0-0.0005          | 0.025                       | 0.001 U.S. | STANDARD | STANDARD   |  |
| 0.013-0.026     | 0.0005-0.0010       | 0.025                       | 0.001 U.S. | 0.025    | 0.001 U.S. |  |
| 0.026-0.039     | 0.0010-0.0015       | 0.050                       | 0.002 U.S. | 0.025    | 0.001 U.S. |  |
| 0.039-0.052     | 0.0015-0.0020       | 0.050                       | 0.002 U.S. | 0.050    | 0.002 U.S. |  |

CA9330-A

#### Crankshaft

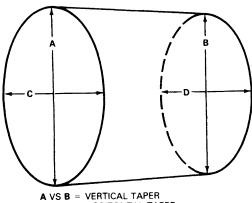
#### Cleaning

CAUTION: Handle the crankshaft with care to avoid possible damage to the finished surfaces.

Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or undersize condition. For specifications, refer to the appropriate engine section.

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



C VS D = HORIZONTAL TAPER A VS C AND B VS D = OUT OF ROUND

A10094-1A

On an engine used with a manual transmission, check the fit of the clutch pilot bearing in the bore of the crankshaft. A needle roller bearing and adapter assembly is used as a clutch pilot bearing. It is press fit directly into the engine crankshaft and should not be loose. Inspect the inner surface of the bearing for wear or a bell-mouth condition. Check the inside diameter of the bearing to see if it is worn, or damaged. The bearing and adapter assembly cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

Inspect the pilot bearing, when used, for roughness, evidence of overheating or loss of lubricant. Replace if any of these conditions are found.

#### Journals, Refinishing

Dress minor imperfections such as scores, nicks or burrs with an oil stone. If the journals are severely marred or exceed the service limit, they should be refinished to size for the next undersize bearing.

If required, machine the journals to give the proper clearance with the next undersize bearing. If the journals will not clean up to maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes. Polish the journal with a No. 320 grit polishing cloth and engine oil (crocus cloth may also be used as a polishing agent) to obtain a smooth finish.

#### Pistons, Pins and Rings

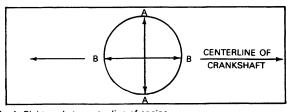
#### **Fitting Pistons**

Pistons are available for service in standard size and the oversize shown in the appropriate engine section under Specifications.

The standard size pistons are color-coded red, blue or yellow on the dome.

Measure the cylinder bore and select the piston to ensure the proper clearance. When the bore diameter is in the lower one-third of the specified range, a red piston should be used. When the bore diameter is in the middle one-third, a blue piston should be used. When the bore diameter is in the upper one-third, a yellow piston should be used.

NOTE: Cylinder bore must be clean and dry, and engine block must remain at room temperature (21°C/70°F) for eight hours before taking cylinder measurements.



A - At Right angle to center line of engine

B - Parallel to center line of engine

Top Measurement: Make 12.70mm (1/2 inch) below top of block deck Bottom Measurement: Make within 12.70mm (1/2 inch) above top of piston - when piston is at its lowest travel (B.D.C)

Bore Service Limit: Equals the average of "A" and "B" when measured at the center of the piston travel.

Taper: Equals difference between "A" top and "A" bottom.

Out-of-Round: Equals difference between "A" and "B" when measured at the center of piston travel.

Refer to Specification tables at end of each engine section.

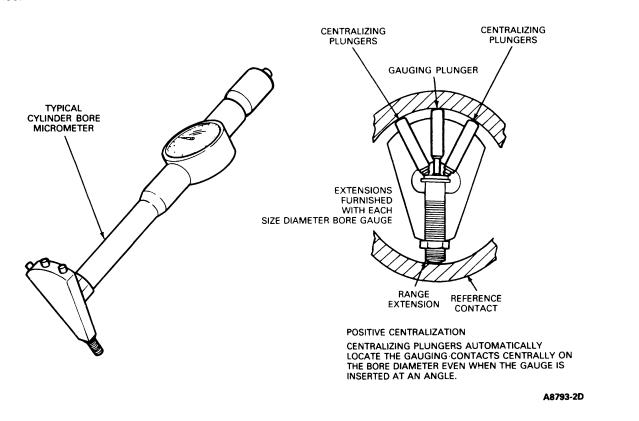
A4165-1G

Measure the piston diameter to ensure the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger or smaller to achieve the specified clearance.

If none can be fitted, refinish the cylinder to provide the proper clearance for the piston.

When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.

If the taper, out-of-round and piston-to-cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service.



If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze using only spring-loaded Engine Cylinder Hone Set T73L-6011-A or equivalent, and only if there is no visible sign of cross-hatch markings on the cylinder walls. (Refer to Cylinder Block, Cylinder Walls, Refinishing). Always clean the cylinder bore thoroughly with detergent and water solution.

- Calculate size piston to be used by taking a cylinder bore check. Follow procedures outlined previously.
- Select proper size piston to provide desired clearance. Measure piston diameter in-line with centerline of piston pin and at 90 degrees to piston pin axis.

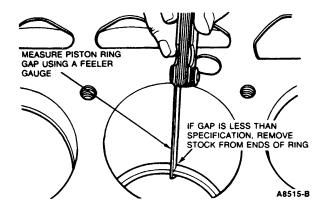
 Ensure piston and cylinder block are at room temperature, 21°C (70°F). After any refinishing operation, allow cylinder bore to cool, and ensure piston and bore are clean and dry before piston fit is checked.

#### **Fitting Piston Rings**

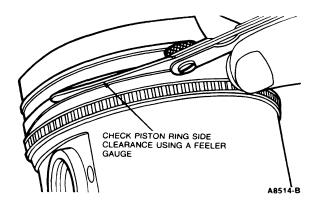
NOTE: Always use a piston ring expanding tool to install rings on a piston.

- Select proper ring set for size of cylinder bore.
- Position ring in cylinder bore in which it is going to be used.
- Push ring down into bore area where normal ring wear is not encountered.
- Position ring in bore so ring is square with cylinder wall. Use caution to avoid damage to ring or cylinder bore.

 Measure gap between ends of ring with a feeler gauge. If ring gap is less than or greater than specified limits, try another ring set. For specifications, refer to appropriate engine section.



- Check ring side clearance of compression rings with a feeler gauge inserted between ring and its lower land. Gauge should slide freely around entire ring circumference without binding. Any wear that occurs will form a step at inner portion of lower land. If lower lands have high steps, piston should be replaced.
- Piston rings should be staggered on the piston to ensure the piston ring end gaps are **not** aligned.

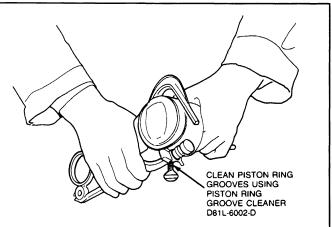


#### Cleaning

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins, and rings with solvent.

CAUTION: Do not use a caustic cleaning solution or a wire brush to clean pistons.

Clean the ring grooves with Piston Ring Groove Cleaner D81L-6002-D or equivalent. Ensure oil ring slots (or holes) are clean.



A8102-B

#### Inspection

Carefully inspect the pistons for fractures at the ring lands, skirts, oil ring slot corners, and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves have a high step, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation or preignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures or damage from detonation or preignition.

Check the piston-to-cylinder bore clearance by measuring the piston and bore diameters. Refer to Specifications in the appropriate engine section for the proper clearance. Refer to Cylinder Block Inspection for the bore measurements procedure. Measure the OD of the piston and check the ring side clearance following the procedure under Fitting Pistons, Pins and Rings.

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod.

Check the OD of the piston pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specifications. For specifications, refer to the appropriate engine section.

Replace all rings that are scored, broken, chipped or cracked. Check the end gap and side clearance. Rings should not be transferred from one piston to another, regardless of mileage.

#### **Connecting Rods**

#### Cleaning

Remove the bearings from the rod and cap. Identify each bearing location if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic cleaning solution.** Blow out all passages with compressed air.

#### Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. For specifications, refer to the appropriate engine section. Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss inside of the piston usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged crankpin, or a tapered connecting rod bore.

Twisted connecting rods can create an identifiable piston skirt wear pattern, but badly twisted rods will disturb the action of the entire piston, rings, and connecting rod assembly and may be the cause of excessive oil consumption.

Check the connecting rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and / or twist exceeds specification, the connecting rod must be replaced.

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and/or if the connecting rod is fractured, it should be replaced. Check the ID of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specification, install a 0.025mm (0.001 inch) oversize piston pin. First, prefit the oversize piston pin to the piston pin bore by reaming or honing the piston to provide 0.007-013mm (0.0003-0.0005 inch) clearance (light slip fit). Assemble the piston, piston pin and connecting rod following the procedure in this section. It is not necessary to ream or hone the pin bore in the connecting rod. Replace damaged connecting rod nuts and bolts.

#### Camshaft

#### Cleaning

Clean the camshaft in solvent and wipe it dry.

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone.

NOTE: If camshaft journals are excessively worn or scored, the camshaft must be replaced. Camshaft journals can be refinished to accommodate 0.38mm (0.015 inch) undersize bearing. If the journals do not "clean up," the camshaft must be replaced.

#### Inspection

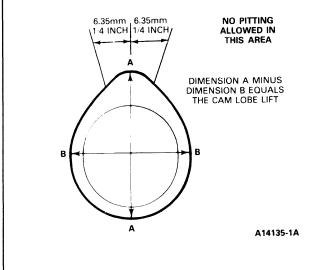
Check camshaft bores for size, taper, roundness, alignment and finish. If any of these exceed the limits given in specifications, install new camshaft bearings.

Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe pitting except in the general area of the lobe toe is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced unless the lobe lift loss has exceeded specification or pitting has occurred in the lobe lift area.

The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers. Refer to Camshaft Lobe Lift.

To measure the camshaft lobe lift, proceed as follows:

- Measure distance between major (A-A) and minor (B-B) diameters of each cam lobe with a Vernier caliper and record readings. The difference in readings on each cam diameter is lobe lift.
- If readings do not meet specification, replace camshaft. For specifications, refer to appropriate engine section.



#### **Hydraulic Tappets**

The tappet assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each tappet separately so as not to intermix. If any part of the tappet assembly needs replacing, replace the entire assembly. If a tappet is worn, it is recommended that all tappets and camshaft be replaced.

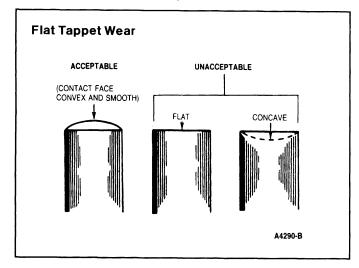
#### Cleaning

Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint-free cloth.

#### Inspection

Inspect the parts and discard the entire lash adjuster, tappet assembly if any part shows pitting, scoring or excessive wear. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the lash adjuster, tappet assembly and check for freeness of operation by pressing down on the plunger. The lash adjusters, tappets can also be checked with a hydraulic tester to test the leakdown rate. Follow the instructions of the test unit manufacturer or the Hydraulic Lash Adjuster, Tappet procedure under Diagnosis and Testing.



#### Oil Pump

#### Cleaning

Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Ensure all dirt and metal particles are removed.

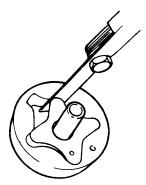
#### Inspection

Refer to specifications in the appropriate engine section for clearances and service limits.

Check the inside of the pump housing and the inner and outer gears for damage or excessive wear.

Check the mating surface of the pump cover for wear. Minor scuff marks are normal, but if the cover, gears or housing surfaces are excessively worn, scored or grooved, replace the pump. Inspect the rotor for nicks, burrs or score marks. Remove minor imperfections with an oil stone.

Measure the inner to outer rotor tip clearance.

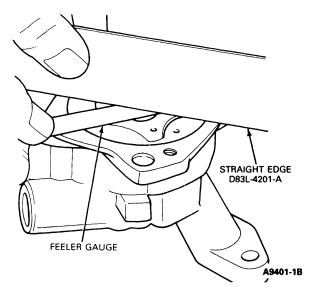


NOTE:
WITH ROTOR ASSEMBLY REMOVED FROM
THE PUMP AND RESTING ON A FLAT
SURFACE, THE INNER AND OUTER ROTOR
TIP CLEARANCE MUST NOT EXCEED 0.30mm
(0.012 IN) WITH FEELER GAUGE INSERTED
13mm (0.5 IN) MINIMUM.

A7541-1A

With the rotor assembly installed in the housing, place a straightedge over the rotor assembly and the housing.

Measure the vertical clearance (rotor end play) between the straightedge and both the inner rotor and the outer race. Maximum clearance must not exceed 0.13mm (0.005 inch).



Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not within specification and/or the spring is worn or damaged, replace the pump. Check the relief valve piston for free operation in the bore.

NOTE: Internal components are not serviced. If any component is out of specification, the pump assembly must be replaced.

#### Oil Pan

#### Cleaning

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly. Ensure all foreign particles are removed.

CAUTION: Do not damage the oil level sensor (if equipped) when cleaning the oil pan.

#### Inspection

Check the pan for cracks, holes or damaged drain plug threads. Check the gasket surface for damage caused by over-tightened bolts. Replace with a new oil pan if repairs cannot be made.

#### **Cylinder Heads**

Replace the head if it is cracked. Do not plane or grind more than 0.254mm (0.010 inch) from original cylinder head gasket surface. Remove all burrs or scratches with an oil stone.

#### Cleaning

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores. Use cleaning solvent to remove dirt, grease and other deposits from the valves with a fine wire brush or buffing wheel.

#### Inspection

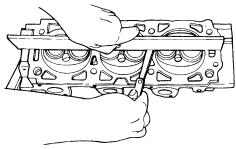
Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Small imperfections of this type can be dressed down using an oil stone. Replace the head if it is cracked.

The following inspection procedures are for a cylinder head that is to be completely overhauled. For individual repair operations, use only the pertinent inspection procedure.

#### **Cylinder Head Flatness**

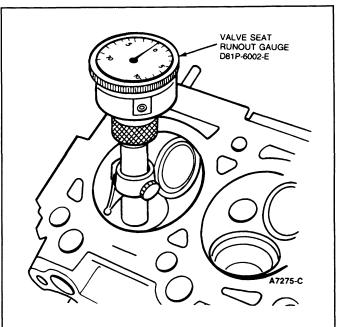
When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface for conformance to specification. For specifications, refer to the appropriate engine section. If necessary to refinish the cylinder head gasket surface, do not plane or grind off more than 0.254mm (0.010 inch).



#### A15267-A

#### **Valve Seat Runout**

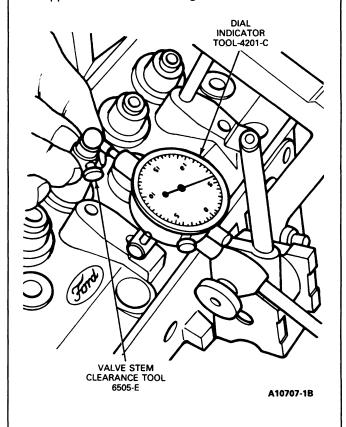
Check the valve seat runout with Valve Seat Runout Gauge D8 1P-6002-E or equivalent as illustrated below. Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. For specifications, refer to the appropriate engine section.



#### Valve Stem-to-Guide Clearance

Check the valve stem-to-valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance TOOL-6505-E or equivalent. Use a flat-end indicator point.

Install the tool on the valve stem until it is fully seated, and tighten the knurled setscrew firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.



Position the dial indicator with its flat tip against the center portion of the tool's spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool. If valve stem-to-valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem as outlined under Valves.

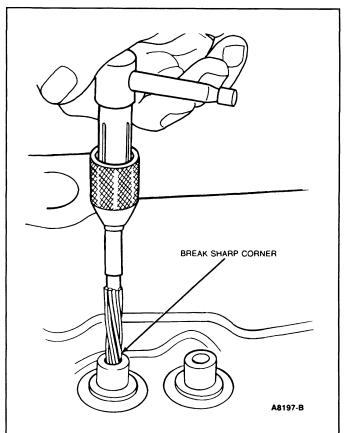
# Valves, Select Fitting

If the valve stem-to-valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.38mm and 0.76mm (0.015 inch and 0.030 inch) are available for service in diameters of 0.41mm and 0.81mm (0.016 inch and 0.032 inch) oversize. Always reface the valve seat after the valve guide has been reamed. Refer to Valve Guides, Reaming.

In the case of valve stem-to-valve guide clearance, the service clearance is intended as an aid to diagnosing engine noise only, and does not constitute a failure or indicate need for service. However, when overhauling or reconditioning a cylinder head, the service clearance should be regarded as a practical working value, and used as a determinant for installing the next oversize valve to ensure extended service life.

# Valve Guides, Reaming

If it becomes necessary to ream a valve guide to install a valve with an oversize stem, a hand reaming kit is available which contains the following reamer and pilot combinations: a 0.38mm (0.015 inch) OS reamer with a 0.76mm (0.03 inch) OS pilot, and a 0.76mm (0.03 inch) reamer with a 0.38mm (0.015 inch) OS pilot.



When replacing a standard size valve with an oversize valve, always use the reamer in sequence (smallest oversize first, and then next smallest, etc.) so as not to overload the reamers. Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

NOTE: If oversize valve stems and oversize stem seals are not available, bore out original guide and install service bushing. Ream ID for specified clearance for standard size valve. Reface valve seat, as required. Install standard size valve stem oil seal.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 45 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less then 0.794mm (1/32 inch) thick after grinding, replace the valve as the valve will run too hot in the engine. The interference angle of the valve and seat should not be lapped out. Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.254mm (0.010 inch) from the end of the valve stem.

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

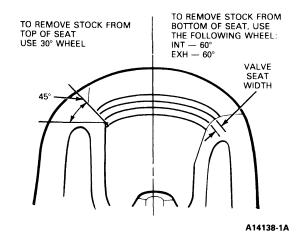
#### Valve Seats, Refacing

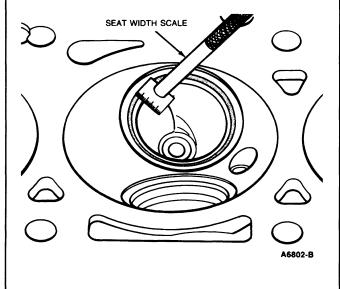
Measure the valve seat width. Reface the valve seat(s) if the width is not within specifications. Refer to the appropriate engine section.

Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve seat grinders and cutters available.

Refacing the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference angle will be maintained. This is important so that the valve and seat will have a compression-tight fit. Ensure refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45 degree angle. Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width. Narrow the seat, if necessary, to bring it within specification. Refer to the appropriate engine section for specifications.





If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specification.

On the intake and exhaust seats, use a 60 degree angle grinding wheel to remove stock from the bottom of the seat (raise the seats). A 30 degree angle wheel is used to remove stock from the top of the seats (lower the seats).

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face.

To do this, coat the seat with Prussion Blue and set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

#### **Valves**

The critical inspection points and tolerances of the valve are illustrated. Refer to specifications for service limits. Refer to the appropriate engine section.

Inspect the valve stem for bends, and the end of the stem for grooves or scoring.

Inspect the valve face and the edge of the valve head for pits, grooves or scores. Inspect the stem for a bend condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Inspect the valve spring assembly, valve spring retainers, locks and sleeves and discard any visually damaged parts.

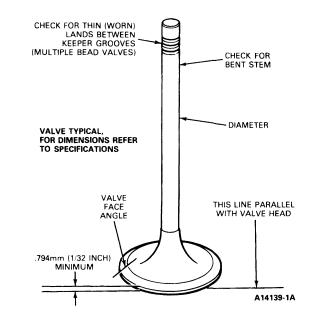
#### Valves, Refacing

Minor pits or grooves may be removed. Discard valves that are severely damaged, if the face runout cannot be corrected by refinishing, or stem clearance exceeds specification. Refer to the appropriate engine section for specifications. Discard any excessively worn or damaged valve train parts.

Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve resurfacing equipment.

The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and valve seat will be to specifications and provide a compression-tight fit.

Ensure refacer grinding wheels are properly dressed. Refer to the following illustration for critical valve dimensions.

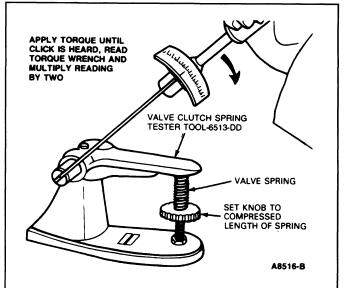


#### **Valve Spring Tension**

Inspect the valve spring, valve spring retainers, and keys for wear or damage. Discard any damaged parts.

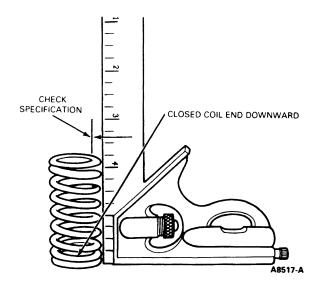
Check the springs for proper pressure at the specified spring lengths using Valve Clutch Spring Tester TOOL-6513-DD or equivalent. Weak valve springs cause poor engine performance. Replace any spring not within specification. For specifications, refer to the appropriate engine section. Manually rotating the valve spring assemblies while installed in the engine, will not determine condition of valve springs.

NOTE: Ensure the springs are reassembled to their OWN ORIGINAL DAMPERS by pushing damper on the spring. DO NOT OPEN damper with any kind of tool in order to reassemble.



#### **Valve Spring Squareness**

Check each spring for squareness using a steel square and a flat surface. Stand the spring and square on end of the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. Refer to the illustration below.



Refer to specifications in the appropriate engine section for out-of-square limits. Follow the same procedure to new valve springs before installation.

# Ensure the proper spring (color-coded) is installed.

NOTE: Ensure the springs are reassembled to their OWN ORIGINAL DAMPERS by pushing damper on the spring. DO NOT OPEN damper with any kind of tool in order to reassemble.

#### Valve Rocker Arm

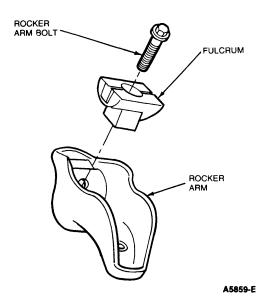
#### Cleaning

Clean all parts thoroughly. Ensure all oil passages are open.

Ensure oil passage in the push rod end of the rocker arm is open.

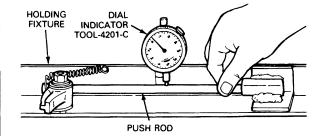
#### Inspection

Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs. Replace any damaged parts.



Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm. Do not attempt to true this surface by grinding. On pedestal mounted rocker arms, check the rocker arm pad, side rails and fulcrum seat for excessive wear, cracks, nicks, or burrs. Check the rocker arm bolt for stripped or broken threads.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator.



A10196-1B

If the push rod is bent beyond specifications, it should be replaced. **Do not attempt to straighten push** rods.

#### Intake Manifold

#### Cleaning

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

#### Inspection

Inspect the manifold for cracks, damaged gasket surfaces, or other problems that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. Clean the EGR exhaust passages. Remove all filings and foreign matter that may have entered the manifold as a result of service.

Check the baffle plate(s) on the underside of the manifold if so equipped. The baffle(s) should be securely fastened.

# **Push Rods**

#### Cleaning

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rods with compressed air.

#### Inspection

Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Replace damaged push rods.

#### **Exhaust Manifold**

#### Cleaning

Remove all gasket or foreign material from all inlet and outlet sealing surfaces of the manifold.

#### Inspection

Inspect the cylinder head joining flanges of the exhaust manifold for evidence of exhaust gas leaks.

Inspect the manifold for cracks, damaged gasket surfaces, or other damage that would make them unfit for further service. Warped or cracked exhaust manifolds must be replaced.

#### **Flywheel**

#### **Automatic Transmission**

#### Inspection

Inspect the flywheel for cracks or other damage that would make it unfit for further service. Inspect the flywheel ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear and flywheel assembly.

With the flywheel installed on the crankshaft, check the gear face runout.

# Flywheel Service Repair: Re-Machine Clutch Surface

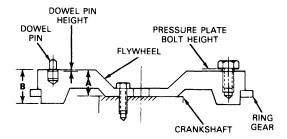
Inspect the flywheel for cracks, heat check or other damage that would make it unfit for further use. Acceptable flywheels may be repaired by polishing with fine grade (400 grit) sandpaper. Flywheels may be resurfaced to remove scratches or grooves. After resurfacing, the flywheel thicknesses must not be less than the dimensions noted in the chart.

Flywheel Resurfacing Machining Requirements:

- Mount flywheel rigidly on crankshaft mounting flange.
- b. After machining:
  - Surface runout must not exceed 0.13mm (0.005 inch) TIR, surface finish must be in the range of 4.0/1.3 micrometer (160/52 microinch).
  - Major diameter of dowel pin (press fit diameter) must not extend above the new surface.
  - The clutch pressure plate retaining bolts must screw into the flywheel under hand torque to within 1.50mm (0.06) of new surface.
  - Flywheels with dimensions less than the charted dimensions must not be used; install new service flywheel.

#### Charts

Dimension "A" is the minimum acceptable dimension from the crankshaft mounting surface to the new resurfaced clutch face surface. Dimension "B" is a referenced minimum acceptable dimension for the overall width of the outer flange.



A15182-A

| Flywheel<br>Part Number | Dimension "A"<br>mm (inch) | Dimension "B"<br>mm (inch) |
|-------------------------|----------------------------|----------------------------|
| E7TZ-6375-A             | 25.40 (1.00)               | 28.45 (1.12)               |
| E8TZ-6375-D             | 22.60 (0.89)               | 23.40 (0.92)               |
| E8TZ-6375-C             | 22.60 (0.89)               | 23.40 (0.92)               |

CA15183-A

Inspect the ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear.

# SPECIAL SERVICE TOOLS

014-00705

# ROTUNDA EQUIPMENT Model Description 112-00030 Oil Leak Detector 059-00009 Compression Tester

Engine Cylinder Leak Detection Kit

CA14140-1B

# SPECIAL SERVICE TOOLS (Continued)

| Tool Number Description |                               | Tool Number   | Description                      |  |  |
|-------------------------|-------------------------------|---------------|----------------------------------|--|--|
| D79P-100-A              | Impact Slide Hammer           | T72C-6165-R   | Rear Oil Seal Replacer           |  |  |
| T50T-100-A              | Impact Slide Hammer           | TOOL-6500-E   | Hydraulic Tappet Leakdown Tester |  |  |
| T59L-100-B              | Impact Slide Hammer           | TOOL-6505-E   | Valve Stem Clearance Tool        |  |  |
| T77L-9533-B             | Jet Plug Remover              | TOOL-6513-DD  | Valve/Clutch Spring Tester       |  |  |
| T58L-101-B              | Puller Attachment             | T79T-6527-A   | Rocker Arm Stud Remover          |  |  |
| D78P-4201-B             | Dial Indicator Mag. Base      | T79T-6527-B   | Rocker Arm Stud Replacer         |  |  |
| D78P-4201-F             | Dial Indicator Bracketry      | TOOL-6565-AB  | Cup Shaped Adapter               |  |  |
| D78P-4201-G             | Dial Indicator 1" Travel      | T86L-6565-A   | Valve Spring Compressor          |  |  |
| TOOL-4201-C             | Dial Indicator with Bracketry | T73L-6600-A   | Pressure Gauge                   |  |  |
| T70P-6000               | Engine Lifting Brackets       | D79P-6666-A   | Spark Plug Boot Pulier           |  |  |
| D81L-6002-A             | Oil Stone                     | D81P-6666-A   | Spark Tester                     |  |  |
| D81L-6002-B             | Plastigage                    | T74P-6666-A   | Spark Plug Wire Remover          |  |  |
| D81L-6002-D             | Piston Ring Groove Cleaner    | T82L-6701-A   | Rear Main Seal Installer         |  |  |
| D81P-6002-E             | Valve Seat Runout Gauge       | T62F-6A527-B3 | Rocker Arm Stud Reamer           |  |  |
| T64L-6011-EA            | Cylinder Ridge Reamer         | T62F-6A527-B5 | Rocker Arm Stud Reamer           |  |  |
| T73L-6011-A             | Cylinder Hone Set             | D83L-4201-A   | Straight Edge                    |  |  |

CA7123-2G

# SECTION 03-01A Engine—4.9L (300 CID) Six-Cylinder

| SUBJECT                         | PAGE      | SUBJECT                              | PAGE      |
|---------------------------------|-----------|--------------------------------------|-----------|
| ADJUSTMENTS                     |           | IN-VEHICLE SERVICE (Cont'd.)         |           |
| Valve Clearance                 | 03-01A-4  | Engine Components                    | 03-01A-7  |
| CLEANING AND INSPECTION         |           | Engine Front Supports                |           |
| DESCRIPTION                     |           | Engine Rear Supports                 |           |
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| Crankcase Ventilation System    | 03-01A-2  | Main Bearing                         |           |
| Emission Calibration Label      | 03-01A-2  | Manifolds                            |           |
| Engine                          | 03-01A-1  | Oil Filter                           | 03-01A-31 |
| Exhaust Emission Control System |           | Oil Pan                              | 03-01A-20 |
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| DISASSEMBLY AND ASSEMBLY        |           | Timing Gears                         |           |
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| Cylinder Head                   |           | Valve Spring, Retainer and Stem Seal | 03-01A-12 |
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| IN-VEHICLE SERVICE              |           | REMOVAL AND INSTALLATION             |           |
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| Camshaft Rear Bearing Bore Plug | 03-01A-26 | Crankshaft                           |           |
| Clutch Pilot Bearings           |           | E-150—E-350                          | 03-01A-33 |
| Connecting Rod Bearing          | 03-01A-29 | Engine Assembly                      | 03-01A-31 |
| Crankcase Ventilation System    | 03-01A-11 | SPECIAL SERVICE TOOLS                | 03-01A-48 |
| Crankshaft Rear Oil Seal        |           | SPECIFICATIONS                       | 03-01A-44 |
| Cylinder Front Cover            | 03-01A-18 | VEHICLE APPLICATION                  | 03-01A-1  |
| Cylinder Head                   | 03-01A-14 |                                      |           |

# **VEHICLE APPLICATION**

E-150 Through E-350, F-150 Through F-350 and Bronco Vehicles

# **DESCRIPTION**

#### Engine

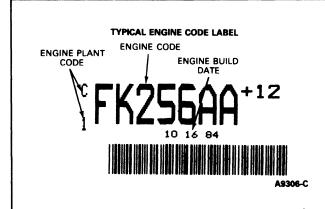
The 4.9L (300 CID) I-6 engine block is made of a special high-grade cast iron. The crankshaft has seven main bearings and is made of precision cast nodular iron. Pistons are aluminum alloy with integral steel struts. The valve rocker arms are stamped steel with powdered metal cylindrical fulcrums. Tappets are hydraulic and are self-adjusting. The 4.9L (300 CID) I-6 engine has exhaust valve rotators. Timing gears are helical gear type. The cam gear is made of phenolic material.

The 4.9L (300 CID) I-6 is the standard engine for E-150—E-350, Bronco, F-150—F-350 (4x2) and F-150—F-250 (4x4).

### **Engine Code Information Label**

Located on the timing gear front cover is the engine code information label containing, among other pertinent data, an engine build date, an engine plant code, and an engine code.

# **DESCRIPTION (Continued)**



#### **Emission Calibration Label**

The emission calibration number label is located on the LH side door or LH door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

NOTE: It is imperative that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.

CALIBRATION ETALONNAGE
CALIBRACIÓN



8-76A-ROO EBAE-6E061-ABY

A10693-1A

# **Exhaust Emission Control System**

The exhaust emission control devices used on these engines are covered in the Engine / Emissions Diagnosis\* manual.

# **Crankcase Ventilation System**

These engines are equipped with a positive, closed-type ventilation system which directs the crankcase vapors to the intake manifold for combustion.

#### **Lubrication System**

Oil from the oil pan sump is forced through the pressure-type lubrication system by a rotor-type oil pump. A spring-loaded relief valve in the pump limits the maximum pressure of the system. Oil relieved by the valve is directed back to the intake side of the pump.

The engine has a full-flow disposable filter or a replaceable element-type filter which filters the entire output of the pump before the oil enters the engine. The filters have an integral relief valve. The relief valve permits oil to bypass the filter if it becomes clogged, thereby maintaining a continuous supply of oil to the engine. An anti-drain back feature is designed into the oil filter system to prevent a reverse flow of oil when the engine is stopped.

From the filter, the oil flows into the main oil gallery. The oil gallery supplies oil to all the camshaft and main bearings.

The crankshaft is drilled from the main bearings to the connecting rod journals to lubricate the rod bearings.

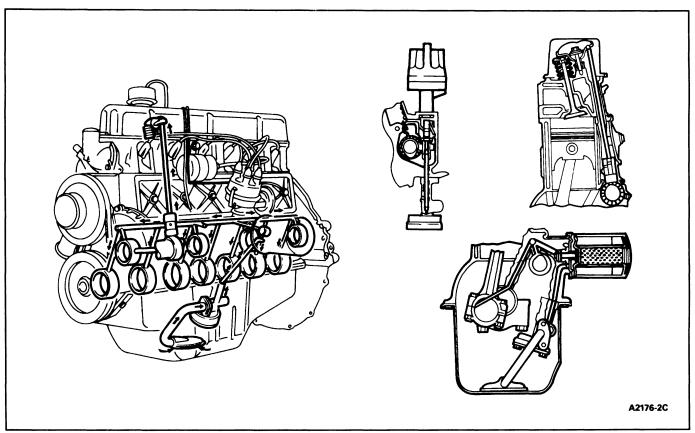
Oil from the floor of the valve tappet chamber is fed through a drilled passage in the cylinder block into the distributor pilot to lubricate the distributor shaft, bushings, and the distributor-to-oil pump intermediate shaft engagement.

The main oil gallery intersects all of the valve tappet bores supplying pressurized oil to the hydraulic valve tappets. A reservoir at each valve tappet bore boss traps oil so that oil is available for valve tappet lubrication as soon as the engine starts.

When the hydraulic tappet is on the base circle of the camshaft lobe (valve closed), the oil hole in the hydraulic tappet is indexed with the oil gallery, and oil flows into the plunger. Oil is also metered through the metering valve (disc) through the oil passages in the push rod cup and it flows up the hollow push rod. In this position, the drilled hole in the ball end of the push rod is indexed with a drilled hole in the rocker arm, and the oil lubricates the upper valve train bearing areas. Excess oil is returned to the oil pan through drain holes along the side of the cylinder head and block.

Excess oil in the push rod chamber drains back into the oil pan through openings along the cylinder block.

# **DESCRIPTION (Continued)**

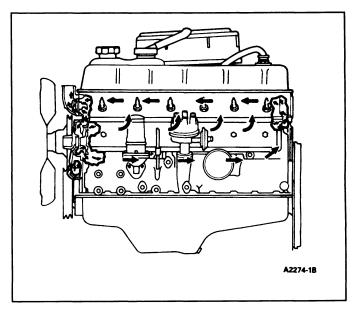


# **Cooling System**

The coolant is drawn from the bottom of the radiator by the water pump, which delivers the coolant to the cylinder block.

As the coolant enters the block, it travels through cored passages to cool the entire length of each cylinder wall. The coolant is then directed upward into the cylinder head where it cools the combustion chambers, valves and valve seats.

The coolant from the cylinder head flows into the coolant outlet housing, past the thermostat if it is open, and into the top of the radiator. If the thermostat is closed, a small portion of the coolant is returned to the water pump for recirculation.



# **DIAGNOSIS AND TESTING**

Refer to Diagnosis and Testing in Section 03-00, Engine, Gasoline—General Service.

#### **ADJUSTMENTS**

#### **Valve Clearance**

A 1.52mm (0.060 inch) shorter push rod or a 1.52mm (0.060 inch) longer push rod is available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the appropriate color code.

Valve stem-to-valve rocker arm clearance should be within specifications with the hydraulic tappet completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if it is not compensated for, the hydraulic valve tappet will collapse and cease to function, and could prevent the valve seat face from properly seating on the valve seat. Valve will be held open.

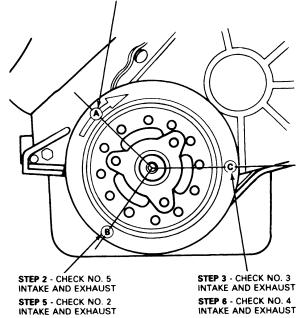
The positive stop rocker arm bolt eliminates the necessity of adjusting the valve clearance. However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and tightened to specification.

To determine whether a shorter or a longer push rod is necessary, make the following check.

- Install an auxiliary starter switch. Crank the engine with the ignition switch in OFF position.
- Make two chalk marks on the crankshaft damper. Space the marks approximately 120 degrees apart so that, with the timing mark, the damper is divided into three equal parts (120 degrees is one-third of the distance around the damper circumference).

STEP 1 - SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE ADJUST NO. 1 INTAKE AND EXHAUST

STEP 4 - CHECK NO. 6 INTAKE AND EXHAUST



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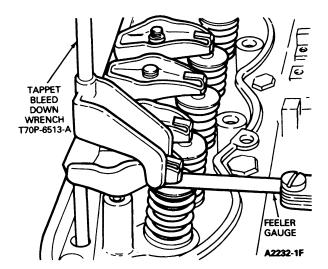
 With No. 1 piston on TDC at the end of the compression stroke, tighten the rocker arm bolts of the No. 1 intake and exhaust valves to specifications.

Then slowly supply pressure to bleed down the hydraulic tappet until the plunger is completely bottomed using Tappet Bleed Down Wrench T70P-6513-A or equivalent.

Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install a shorter push rod.

If the clearance is greater than specifications, install a longer push rod.



4. Repeat this procedure for the remaining set of valves, turning the crankshaft with an auxiliary starter switch, one-third turn at a time, in the direction of rotation. At the same time, adjust the valves in the firing order sequence, 1-5-3-6-2-4.

#### **IN-VEHICLE SERVICE**

The following procedures can be performed with the engine in the vehicle.

When installing nuts or bolts that must be tightened, oil the threads with light weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.** 

Refer to Section 03-00, Engine, Gasoline—General Service for Repair and Cleaning and Inspection procedures. Refer to the end of this section for all engine component bolt torque specifications. Refer to Section 03-05, Engine Accessory Drive for all belt tension specifications.

#### **Engine Front Supports**

The 4.9L (300 CID) I-6 engine for F-150—F-350, Bronco, E-150—E-350 is mounted on three engine mounts. These models have two front mounts located on each side of the engine and one rear mount located on the transmission extension housing.

#### E-150-E-350

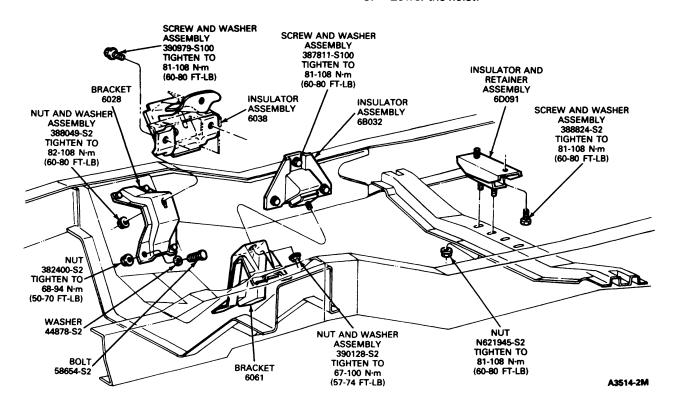
#### Removal

- Raise the vehicle on a hoist.
- Remove the front support insulator-to-support bracket nuts and washers from both insulators.
- Place a Rotunda Transmission Jack 066-00017
  or equivalent under the engine oil pan and position
  a wood block between the jack and oil pan. Raise
  the engine just enough to take the weight off the
  support brackets.

- The support brackets are mounted to the front frame crossmember with four bolts and locknuts. If these are to be removed, loosen the four locknuts on each support bracket and remove from the crossmember.
- Remove the insulator assembly-to-cylinder block bolts and remove the front support insulators.

#### Installation

- Install the insulators on the engine block and tighten the bolts to 81-108 N·m (60-80 ft-lb).
- Install the four bolts and locknuts on the front crossmember support brackets. Tighten to 81-108 N·m (81-108 ft-lb).
- Lower the engine until the front support insulators engage the support brackets. Remove the transmission jack.
- 4. Install the front support insulator-to-support bracket nuts and washers. Tighten the nuts to 67-100 N⋅m (57-74 ft-lb).
- 5. Lower the hoist.



#### Double Front Mount F-150 — F-250 and Bronco

The following procedures apply to either a RH or LH installation.

#### Removal

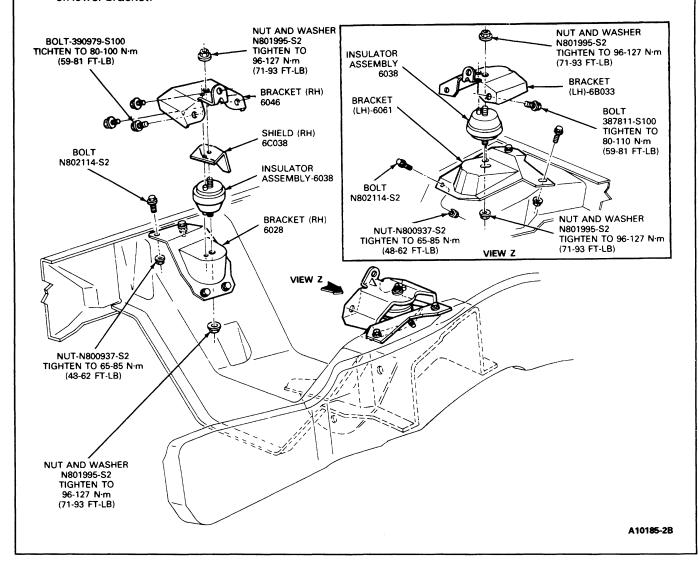
- Remove the upper and lower nut and washer assemblies from the insulator assembly. If only one insulator is being removed, loosen nut and washer assemblies on opposite insulator.
- Using a jack and a wood block placed under the oil pan, raise the engine to allow just enough clearance for removal of the mount.

- Remove the RH or LH mount, and shield (RH mount only).
- 4. Remove three bolts securing upper bracket.
- 5. Remove nuts and bolts securing lower bracket.

#### Installation

- Position the lower bracket and install new bolts and nuts. Tighten to 65-85 N·m (48-62 ft-lb).
- 2. Position upper bracket and install bolts. Tighten to 80-110 N·m (59-81 ft-lb).
- Align locator pin with hole and position insulator on lower bracket.

- Install lower nut and washer assembly finger tight.
- 5. On RH insulator, position shield.
- Lower the engine carefully to make sure the insulator stud and pin engage the upper bracket mounting hole.
- Install the nut and washer on the upper insulator stud. Tighten the upper and lower stud nuts to 96-127 N-m (71-93 ft-lb).
- 8. If only one insulator was removed, tighten the other insulator at the support brackets.



# **Engine Rear Supports**

F-150-F-350 and Bronco

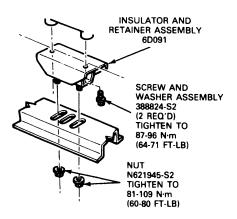
#### Removal

1. Remove the attaching bolts, nut and washers.

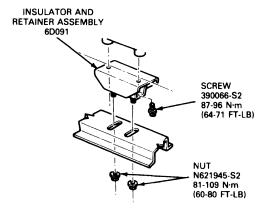
 Raise the transmission slightly to provide clearance and remove the insulator and insulator retainer.

#### Installation

- Position the insulator and retainer. Install the insulator-to-extension housing, lockwashers and bolts.
- Lower the transmission and install the insulator-to-frame crossmember bolt. Tighten the nut and bolts to specifications.



INSTALLATION FOR F-150 - F-350, BRONCO (4x4)



INSTALLATION FOR F-150 - F-350 (4x2)

A5522-1G

# E-150-E-350

#### Removal

- Raise the vehicle on a hoist. Place a transmission jack, such as Rotunda 066-00017 or equivalent, under the transmission and raise it slightly so the transmission weight is not supported by the rear support insulator.
- Remove the insulator-to-crossmember and transmission extension housing locknuts and bolts.
- 3. Remove the rear support insulator.

#### Installation

- Position the rear support insulator between the transmission extension housing and vehicle crossmember. Refer to the previous illustration for E-150—E-350 for the proper position of the support insulator.
- Install the support insulator attaching bolts and locknuts. Tighten the locknuts to 68-94 N⋅m (50-70 ft-lb).

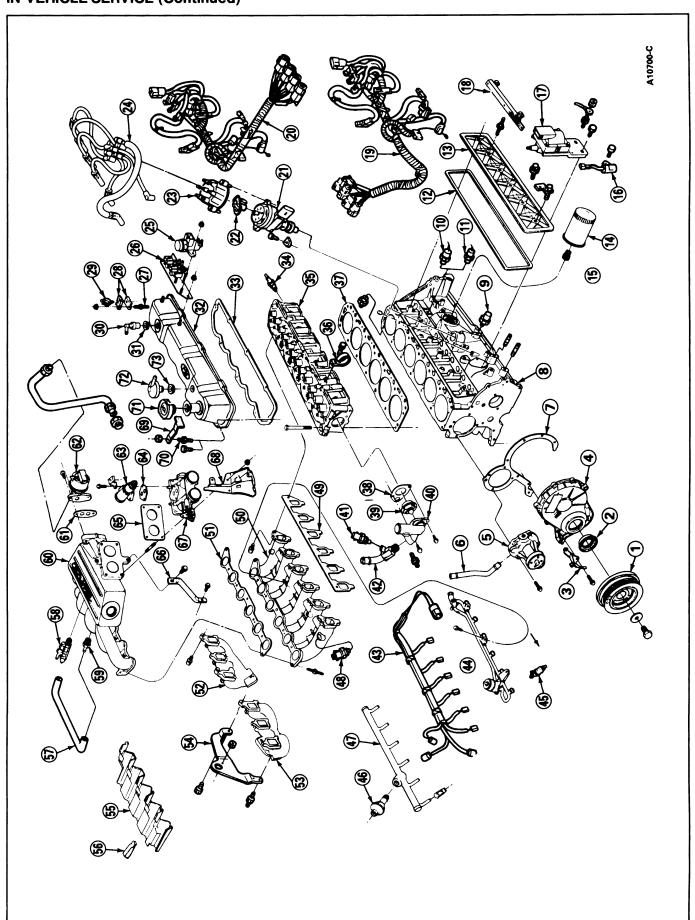
WARNING: ON 138 INCH WHEEL BASE VEHICLES, REMOVE FUEL RESERVOIR TO ELIMINATE ANY PART DAMAGE DUE TO REMOVING THE REAR TRANSMISSION SUPPORT CROSSMEMBER. REFER TO SECTION 10-01A, FUEL TANKS AND LINES AND FUEL EVAPORATIVE EMISSION CONTROL SYSTEM.

Lower the transmission and remove the transmission jack. Lower the vehicle.

#### **Engine Components**

The following exploded views of the engine are typical and will serve as a reference for the procedures. The numbers and part description shown are basic part numbers corresponding with the Ford Master Parts Catalog.

Refer to the end of this section for all specifications and torque values.



| Ref.<br>No. | Basic<br>Part No. | Description                          | Ref.<br>No. | Basic<br>Part No. | Description                 | Ref.<br>No. | Basic<br>Part No. | Description                  |
|-------------|-------------------|--------------------------------------|-------------|-------------------|-----------------------------|-------------|-------------------|------------------------------|
| 1           | 6316              | Damper Assy.                         | 26          | 9D474             | Solenoid and Bracket Assy.  | 51          | 9H486             | Gasket                       |
| 2           | 6700              | Front Seal                           | 27          | 390056-S          | Bolt (Studded Head)         | 52          | 9431              | Exhaust Manifold             |
| 3           | 6M025             | Timing Pointer                       | 28          | 14A163            | Retainer                    | 53          | 9430              | Exhaust Manifold             |
| 4           | 6059              | Front Cover                          | 29          | 14A163            | Clip                        | 54          | 17A084            | Lifting Eye                  |
| 5           | 8501              | Water Pump                           | 30          | 6B890             | PCV Valve Assy.             | 55          | 9F460             | Heat Shield                  |
| 6           | 8555              | Connector Tube                       | 31          | 6K780             | Grommet                     | 56          | 390717            | Spring Clip                  |
| 7           | 6020              | Gasket                               | 32          | 6582              | Valve Rocker Arm Cover      | 57          | 6K817             | Vacuum Hose (Molded)         |
| 8           | 6010              | Block Assy.                          | 33          | 6584              | Gasket                      | 58          | 9D446             | Vacuum Fitting               |
| 9           | 12A699            | Sensor                               | 34          | 12405             | Spark Plug                  | 59          | 390659            | PCV Connector                |
| 10          | 9D290             | Oil Pressure Sending Unit (E-Series) | 35          | 6049              | Cylinder Head               | 60          | 9424              | Upper Intake Manifold        |
| 11          | 9278              | Oil Pressure Sending Unit (F-Series) | 36          | 45334             | Strap (E-Series)            | 61          | 9D476             | Gasket                       |
| 12          | 6521              | Gasket                               | 37          | 6051              | Gasket                      | 62          | 9F483             | EGR Valve                    |
| 13          | 6519              | Cover                                | 38          | 8255              | Gasket                      | 63          | 9F715             | Air Bypass Valve Assy.       |
| 14          | 6714              | Oil Filter                           | 39          | 8575              | Thermostat — Water          | 64          | 9F670             | Gasket                       |
| 15          | 6890              | Insert                               | 40          | 8594              | Water Outlet Connection     | 65          | 9E936             | Gasket                       |
| 16          | 18801             | RFI Capacitor                        | 41          | 12A648            | Coolant Sensor              | 66          | 9J444             | Bracket                      |
| 17          | 12A310            | Ignition Coil and Bracket Assy.      | 42          | 18599             | Elbow                       | 67          | 9E926             | Throttle Body Assy.          |
| 18          | 14A282            | Retainer                             | 43          | 9D930             | Wiring Harness Assy.        | 68          | 9278              | Bracket                      |
| 19          | 14289             | Wiring (E-Series)                    | 44          | 9S441             | Fuel Rail Assy.             | 69          | 14A163            | Bracket (E-Series)           |
| 20          | 14289             | Wiring (F-Series)                    | 45          | 9F593             | Fuel Injector               | 70          | 390056-S          | Bolt (Studded Head E-Series) |
| 21          | 12A332            | Distributor                          | 46          | 9A487             | Check Valve                 | 71          | 6766              | Oil Fill Cap                 |
| 22          | 12200             | Rotor                                | 47          | 9B445             | Exhaust Air Supply Manifold | 72          | 6A768             | Filter Assy.                 |
| 23          | 12106             | Сар                                  | 48          | 12A697            | ACT Sensor                  | 73          | 6K780             | Grommet                      |
| 24          | 12286             | Wire Assy.                           | 49          | 9439              | Gasket                      |             |                   |                              |
| 25          | 9J459             | EVR Solenoid                         | 50          | 9K461             | Lower Intake Manifold       |             |                   |                              |

A15263-A

IN-VEHICLE

SERVICE

(Continued)

# Crankcase Ventilation System

#### Removal

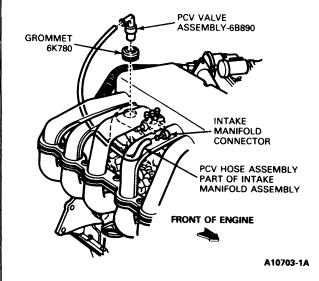
- Grasp the positive crankcase ventilation (PCV)
  regulator valve and pull upward to remove it from
  the rocker arm cover.
- 2. Remove the PCV valve from the vent hose.
- Remove the air inlet hose from the crankcase filter cap and air cleaner.

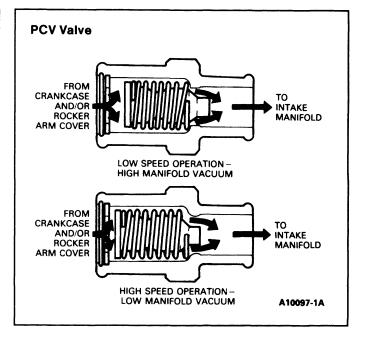
#### Installation

- Install the hose on the inlet tube in the intake manifold. Install the PCV valve in the hose.
- Insert the PCV valve into the rocker arm cover mounting grommet.
- Connect the air inlet hose to the crankcase filter cap and air cleaner.
- Operate the engine and check for leaks.

WARNING: DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND BLADE SEPARATION.

# Typical Closed-Type Crankcase Ventilation System

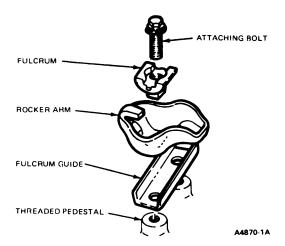




# Valve Rocker Arm Cover and Rocker Arm Removal

- Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body inlet tubes.
- Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring.
   Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
- Remove the fuel line from the fuel rail. Do not bend the fuel line.
- Remove the upper intake and throttle body assembly.
- Remove the PCV valve from the valve rocker arm cover. Remove the crankcase filter. Remove the cover bolts and remove the valve rocker arm cover. Inspect the rocker arm cover bolts for worn or damaged seals under the bolt heads and replace as necessary.

Remove the valve rocker arm bolt, fulcrum seat and rocker arm.



#### Installation

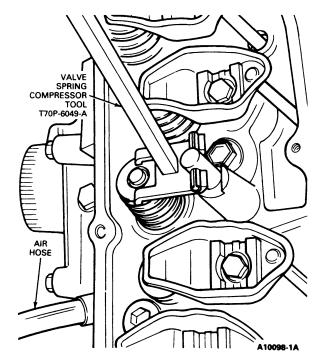
- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stem.
- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the rocker arm fulcrum seat and the fulcrum seat socket in the rocker arm. Install the valve rocker arm, fulcrum seat and rocker arm bolt. Adjust the valve clearance following the procedure under Valve Clearance Adjustment.
- Clean the valve rocker arm cover and the cylinder head gasket surface. Place the new gasket on cylinder head making sure that the tabs of the gasket face down towards the head. No sealer or adhesive is necessary.
- 4. Install the cover on the cylinder head. Make sure the gasket seats evenly all around the head. Partially tighten the cover bolts in sequence, starting at the middle bolts. Then tighten the bolts to 5-9 N·m (4-7 ft-lb) in the same sequence.
- Install the PCV valve in the rocker arm cover.
   Install the accelerator cable bracket on the upper intake manifold and connect the cable to the throttle body.
- Install the upper intake and throttle body assembly.
- 7. Install the fuel line at the fuel rail.
- 8. Connect the inlet air hose to the crankcase filter cap.
- 9. Install throttle body inlet tubes.

# Valve Spring, Retainer and Stem Seal

Broken valve springs or worn or damaged valve stem seals and retainers may be replaced without removing the cylinder head providing damage to the valve or valve seat has not occurred.

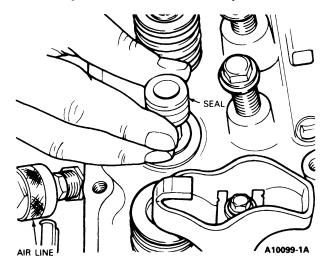
#### Removal

- Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body inlet tubes.
- Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring.
   Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
- Remove the fuel line from the fuel rail. Do not bend the fuel line.
- Remove the upper intake and throttle body assembly.
- Remove the PCV valve from the valve rocker arm cover and remove the valve rocker arm cover.
   Remove the applicable spark plug.
- 6. Crank the engine until the applicable piston is on TDC at the end of the compression stroke.
- Install a Valve Holdup Air Adapter TOOL-6513-ABA or equivalent in the spark plug hole and connect the air line.



8. Remove the applicable valve rocker arm bolt, fulcrum seat, valve rocker arm and push rod. Place a block of wood on top edge of valve spring cap and tap moderately with a hammer to unlock valve keys. Install the bolt and position the Valve Spring Compressor T70P-6049-A or equivalent as shown in the previous illustration. Compress the valve spring and remove the retainer locks, spring retainer and valve spring. Remove and discard the valve stem seal.

If air pressure fails to hold the valve in the closed position during this operation, it can be presumed that the valve is not seating or is damaged. If this condition occurs, remove the cylinder head for further inspection.



- If air pressure has forced the piston to the bottom
  of the cylinder, any removal of air pressure will
  allow the valve to fall into the cylinder. A rubber
  band, tape or string wrapped around the end of
  the valve stem will prevent this condition and will
  still allow enough travel to check the valve for
  binds.
- 10. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head for repairs. Refer to Section 03-00, Engine, Gasoline—General Service.
- If the condition of the valve proved satisfactory, hold the valve in the closed position and apply air pressure within the cylinder.

#### Installation

- Oil the valve stem with heavy engine oil and install a new valve stem seal. Place the spring in position over the valve. Ensure the closed coil end is next to the cylinder head.
  - Install the valve spring retainer. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and bolt.
- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to both ends of the push rod. Install the push rod. Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stem.

- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the fulcrum seat and socket. Install the valve rocker arm, fulcrum seat, fulcrum guide and bolt. Check the valve clearance following the procedure under Valve Clearance.
- Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
- Clean the valve rocker arm cover and cylinder head gasket surface. Install the new gasket on the cover and position the cover on the cylinder head, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and tighten them in sequence (starting in the center) to 5-9 N·m (4-7 ft-lb).
- Install the PCV valve in the rocker arm cover.
   Install the accelerator cable bracket on the upper intake manifold and connect the cable to the throttle body.
- Install the upper intake and throttle body assembly.
- Install the fuel line at the fuel rail.
- Connect the inlet air hose to the crankcase filter cap.
- 10. Install throttle body inlet tubes.

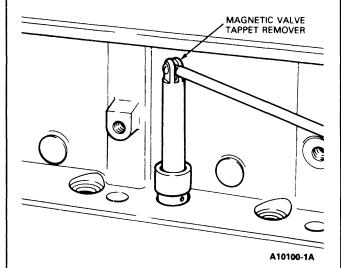
# Valve Tappet

#### Removal

- Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body inlet tubes.
- Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring. Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
- Remove the fuel line from the fuel rail. Do not bend the fuel line.
- Remove the upper intake and throttle body assembly.
- Remove the coil bracket attaching bolt or "E" core assembly attaching nuts and position the coil out of the way.
- 6. Remove the valve rocker arm cover.
- Disconnect the spark plug wires at the spark plugs using Spark Plug Wire Remover T74P-6666-A or equivalent. Remove secondary high tension wire from the coil. Remove the distributor cap and spark plug wire assembly.
- Remove the valve push rod cover.

9. Loosen the rocker arm bolts until the rocker arm(s) can be disengaged from the push rod(s). Remove the push rod(s). Remove the valve tappet(s) with the tool shown. If more than one push rod and valve tappet is removed, do so in sequence and place the parts in a rack so they can be installed in their original locations.

Refer to Section 03-00, Engine, Gasoline—General Service for the cleaning, inspection and testing procedures.



#### Installation

- Clean the external surfaces of the valve tappets, rocker arm cover, push rod cover, cylinder head and block gasket surfaces.
- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the cam lobe contact surface of the valve tappet(s). Coat the rest of the valve tappet(s) with engine oil. Install the valve tappets with the tool shown under Removal.
- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to both ends of the push rod(s). Install the push rod(s) in sequence. Engage the rocker arm(s) with push rod(s) and tighten the rocker arm bolts sufficiently to hold the push rod(s) in place.
   Ensure each push rod is properly seated in the valve tappet socket.
- 4. Adjust the valve clearance as outlined.
- 5. Coat one side of a new push rod cover gasket with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil resistant sealer, and position to the push rod cover. Install the push rod cover. Tighten the cover screws in sequence to 2.8-4.0 N-m (25-35 in-lb). Clean the rocker arm cover. Place the new gasket in the rocker arm cover. Install the rocker arm cover and tighten the bolts to 7.9-11.9 N-m (70-105 in-lb). Install the PCV valve in the rocker arm cover.

- 6. Position the coil assembly on the cylinder head and install the attaching bolt or nuts.
- Install the distributor cap and spark plug wire assembly. Connect the spark plug wires and coil secondary high tension wire.
- Install the accelerator cable bracket on the upper intake manifold and connect the cable to the throttle body.
- Install the fuel line at the fuel rail.
- 10. Install the throttle body inlet tubes.

# Cylinder Head

#### Removal

If the cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly. Transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, reface the valves and check valve guide clearances before assembling the used parts to the new cylinder head. Refer to Section 03-00, Engine, Gasoline—General Service.

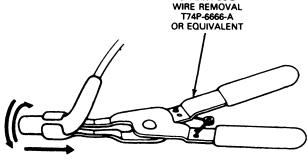
- Drain the cooling system and the crankcase. Remove the hood. Remove the throttle body inlet tubes. Remove air conditioner compressor and condenser. Refer to applicable section in Group 12 in the Body/Chassis/Electrical Manual.
- Disconnect the battery ground cable. Disconnect the heater hose from the water pump and coolant outlet housing. Disconnect the flexible fuel line from the fuel pump.
- 3. Remove the radiator. Refer to Section 03-03, Engine Cooling.
- Remove the cooling fan, viscous fan drive, water pump pulley and fan drive belt as outlined.
- Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring.

On a vehicle with power brakes, disconnect the vacuum line at the intake manifold.

On a vehicle with an automatic transmission, disconnect the transmission kickdown cable at the throttle body.

- Disconnect the exhaust manifold from the muffler inlet pipe. Disconnect the body ground strap and the battery ground cable at the engine.
- Disconnect the Electronic Engine Control (EEC) harness from all sensors.
- Disconnect the engine wiring harness at the ignition coil, coolant temperature sending unit and oil pressure sending unit. Position the harness out of the way.

- Remove the alternator mounting bolts and position the alternator out of the way, leaving the wires attached. Remove the air pump from bracket. Remove the alternator / air pump bracket from engine.
- 10. Remove power steering pump from the mounting brackets and position it right side up and to one side, leaving the lines attached. If equipped with an air compressor, bleed the air system and disconnect the two air pressure lines at the compressor. Remove AC compressor from bracket. Remove the power steering / AC bracket from engine.
- Remove the coil bracket attaching bolts and position the coil out of the way.
- Remove the valve rocker arm cover. Loosen the rocker arm bolts so that the rocker arms can be rotated to one side.
- Remove the valve push rods in sequence and identify them so that they can be installed in their original position.
- Disconnect the spark plug wires at the spark plugs using Spark Plug Wire Remover T74P-6666-A or equivalent.



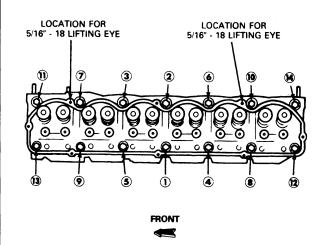
SPARK PLUG

TWIST AND PULL

B3496-1D

15. Remove the cylinder head bolts. Install the cylinder head lifting eyes using Engine Lifting Bracket T70P-6000 or equivalent, in the locations shown. Position a floor crane and attach the hoist and lifting sling to the lifting eyes using Rotunda Engine Sling 014-00036 Sling and Rotunda Floor Crane 014-00133 or equivalents. Lift the cylinder head and intake and exhaust manifolds assemblies off the engine. Do not pry between the head and block as the gasket surfaces may become damaged.

# Cylinder Head Bolts Tightening Sequence



A10351-1A

#### Installation

- Clean the cylinder head and cylinder block gasket surfaces. Clean the exhaust manifold and muffler inlet pipe gasket surfaces.
- If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the head and block gasket surfaces. Refer to Section 03-00, Engine, Gasoline—General Service.
- Position the gasket over the dowel pins on the cylinder block.
- Install lifting eyes on the cylinder head in the location shown and use a floor crane and lifting sling to lift the cylinder head over the cylinder block. Lower it carefully until it is properly positioned on the block and dowel pins. Remove the hoist and lifting eyes.
- Coat the threads of the cylinder head bolts with engine oil. Install the bolts.
- Tighten the bolts in numerical sequence shown. Bolts are tightened in three steps.
  - 1st step—tighten all bolts to 67-75 N·m (50-55 ft-lb).
  - 2nd step—tighten all bolts to 82-88 N·m (60-65 ft-lb).
  - 3rd step—tighten all bolts to 94-115 N·m (70-85 ft-lb).

When cylinder head bolts have been tightened it is not necessary to re-tighten the bolts after extended operation.

 Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to both ends of the push rods. Install the push rods in their original bores, positioning the lower end of the rods in the valve tappet sockets.

- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the rocker arm fulcrum seat and the fulcrum seat socket in the rocker arm. Position the rocker arms and tighten the rocker arm bolt just enough to hold the push rods in position. Check the valve clearance as outlined.
- Clean the valve rocker arm cover. Place the new gasket and position the cover, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and tighten in sequence (starting in the center) to 7.9-11.9 N-m (70-105 in-lb).
- Connect the spark plug wires to the spark plugs.
- Connect the crankcase vent hose to the inlet tube in the intake manifold. Install the PCV valve in the valve rocker arm cover.
- Install the exhaust manifold-to-muffler inlet pipe lockwashers and nuts. Tighten the nuts to specification. Refer to Section 09-00, Exhaust System.
- Connect the engine ground strap and the battery ground cable.
- Connect Electronic Engine Control (EEC) harness to all sensors.
- On a vehicle with an automatic transmission, connect the kickdown cable to the throttle body.
  - Connect the accelerator linkage to the throttle body and install the retracting spring.
  - On a vehicle with power brakes, connect the brake vacuum line to the intake manifold.
- Connect the coil primary wire, oil pressure and coolant temperature sending unit wires, flexible fuel line, heater hoses and the battery positive cable.
- install the alternator and air pump on the mounting bracket. Install assembly on engine.
  - Install the power steering / AC bracket on engine. Install the AC compressor and power steering pump on the mounting brackets.
  - Tighten the alternator, power steering pump and air compressor mounting bolts to specification. Refer to Section 03-05, Engine Accessory Drive.
- Install the water pump pulley, viscous fan drive, (RH threads on fan clutch), cooling fan and drive belt. Tighten the fan bolts to 16.2-24.4 N-m (12-18 ft-lb).
- 19. Install the radiator. Connect the radiator lower hose to the water pump and the radiator upper hose to the coolant outlet housing. Connect the air compressor lines. If removed, install air conditioner compressor and condenser.
  - On a vehicle with an automatic transmission, connect the oil cooler lines.
- 20. If applicable, install and adjust the hood.

- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.
- Perform EEC Quick Test to check the function of the EEC system. Refer to Engine / Emissions Diagnosis\* manual.
- On a vehicle with standard transmission, check for correct clutch operation.
  - On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05, Shift Control Linkage. Check the fluid level and add as required to bring it to the proper level on the oil indicator.
- 24. Install the throttle body intake tubes.

#### **Manifolds**

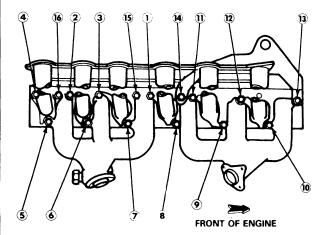
#### Removal

- Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body inlet hoses.
- Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring.
   Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
- 3. Remove the fuel line from the fuel rail. Do not bend the fuel line.
- Remove the upper intake and throttle body assembly.
- Disconnect all the vacuum lines. Label the lines so they are re-installed properly.
- Disconnect the inlet pipe from the exhaust manifolds.
- Disconnect the power brake vacuum line (if so equipped).
- Remove the bolts attaching the manifolds to the cylinder head. Lift the manifolds from the engine. Remove and discard the gaskets.

#### Installation

- Clean the mating surfaces of the cylinder head and manifolds.
- If one of the manifolds is to be replaced, remove the tube fittings from the discarded manifolds and install them in the new manifold as required. Also install new studs in the new manifold.
- 3. Install a new intake manifold gasket.
  - NOTE: Combination intake / exhaust gasket is not to be used on a new exhaust manifold. Gasketing of the exhaust manifold is only recommended when the original exhaust manifold is reinstalled, in order to prevent leakage.

4. Coat the mating surfaces lightly with Steering Gear Grease C3AZ-19578-A (ESW-M1C87-A) or equivalent graphite grease. Place the manifold assemblies in position against the cylinder head. Make sure that the gasket has not become dislodged. Install the attaching washers, bolts and nuts. Tighten the bolts and nuts on intake manifold to 30-43 N·m (22-32 ft-lb) and on exhaust manifold to 30-43 N·m (22-32 ft-lb) in the sequence shown.



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- 5. Connect the inlet pipe to the exhaust manifold. Tighten the nuts to specifications.
- Connect the crankcase vent hose to the intake manifold and position the hose clamp.
- 7. Install the upper intake and throttle body assembly using new gaskets.
- Install the exhaust manifold-to-muffler inlet pipe lockwashers and nuts. Tighten the nuts to specification. Refer to Section 09-00, Exhaust System.
- Connect the engine ground strap and the battery ground cable.
- Connect Electronic Engine Control (EEC) harness to all sensors.
- 11. On a vehicle with an automatic transmission, connect the kickdown cable to the throttle body.
  - Connect the accelerator linkage to the throttle body and install the retracting spring.
  - On a vehicle with power brakes, connect the brake vacuum line to the intake manifold.
- Connect the coil primary wire, RFI capacitor (on coil bracket), oil pressure and coolant temperature sending unit wires, flexible fuel line, heater hoses and the battery positive cable.
- Install the alternator on the mounting bracket.
   Install the power steering pump on the mounting brackets.

- Install the water pump pulley, viscous fan drive, RH threads on fan clutch, cooling fan and drive belt. Tighten the fan bolts to 16.2-24.4 N-m (12-18 ft-lb).
  - Tighten the alternator, power steering pump and air compressor mounting bolts to specification. Refer to Section 03-05, Engine Accessory Drive.
- 15. Install the radiator. Connect the radiator lower hose to the water pump and the radiator upper hose to the coolant outlet housing. Connect the air compressor lines. If removed, install air conditioner compressor and condenser.
  - On a vehicle with an automatic transmission, connect the oil cooler lines.
- 16. If applicable, install and adjust the hood.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.
- Perform EEC Quick Test to check the function of the EEC system. Refer to Engine / Emissions Diagnosis\* manual.
- On a vehicle with manual transmission, check for correct clutch operation.
  - On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05, Shift Control Linkage. Check the fluid level and add as required to bring it to the proper level on the oil indicator.
- 20. Install the throttle body intake tubes.

#### **Water Pump**

# Removal

- Drain the cooling system. Loosen the alternator adjusting arm bolt and remove the alternator drive belt. On a vehicle with an air compressor, remove the compressor belt.
- Remove the fan, viscous fan drive, (RH thread on clutch), and pulley as outlined.
- 3. Disconnect the heater hose, radiator lower hose and radiator supply line at the water pump.
- 4. Remove the bolts attaching the water pump to the block. Remove the pump and gasket.

#### Installation

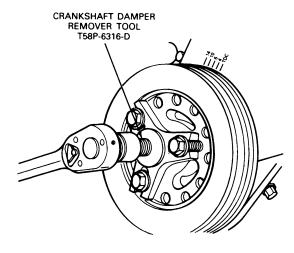
- Remove the fittings from the old pump and install them on the new pump. Clean all gasket material from the mounting surfaces of the water pump and cylinder block.
- Position a new gasket, coated on both sides with sealer, on the water pump.

- Install the pump body on the block. Install the pump attaching bolts, coated with sealer, and tighten the bolts to 17-24 N-m (12-18 ft-lb).
- 4. Connect the radiator lower hose, radiator supply line and heater hose. Install the pulley and fan. Install the alternator belt and adjust the belt tension. On a vehicle with an air compressor, install the air compressor belt and adjust the belt tension to specifications. Refer to Section 03-05, Engine Accessory Drive. Fill and bleed the cooling system. Operate the engine and check for leaks.

#### **Cylinder Front Cover**

#### Removal

- 1. Drain the cooling system.
- 2. Remove the shroud and radiator.
- Remove the drive belt, power steering bracket bolts and swing aside. Remove the fan and pulleys as outlined.
- Remove the screw and washer from the end of the crankshaft and remove the damper using Crankshaft Damper Remover T58P-6316-D or equivalent.



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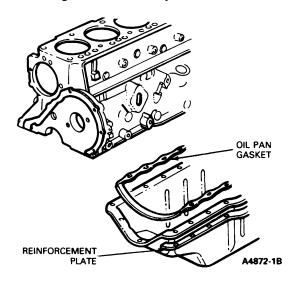
 Remove the front oil pan and front cover attaching screws. Loosen the first six bolts on each side of the pan. Lightly push pan down so it does not exert any upward force on the front cover, which may affect front seal alignment.

- CAUTION: Avoid foreign material from entering the crankcase during service work or the crankcase oil will have to be changed.
- Remove the cylinder front cover and discard the gasket. Replace crankshaft oil seal whenever the cylinder front cover is removed.

#### Installation

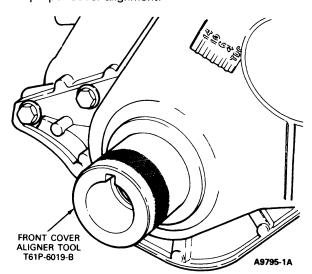
- Clean front cover and block gasket surfaces. Also, clean any oil on oil pan gasket as it will be used over.
- Coat front cover gasket surfaces of the block and cover with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil resistant sealer. Position a new front cover gasket on the block.
- Apply Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent to the block / pan junction and a small bead on oil pan gasket sealing surface of front cover. This provides an additional seal between front cover and the used oil pan gasket.

NOTE: When applying RTV sealant always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.

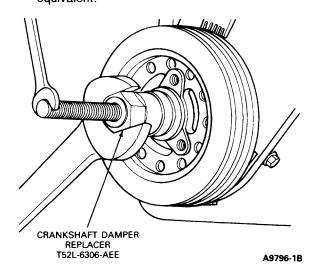


4. Position the front cover assembly over the end of the crankshaft and against the cylinder block. Start the cover and pan attaching screws. Slide the Front Cover Aligner T61P-6019-B or equivalent over the crank stub and into the seal bore of the cover. Tighten attaching oil pan screws to 14-20 N·m (10-15 ft-lb) and front cover screws to 17-24 N·m (12-18 ft-lb).

NOTE: Tighten front cover screws first to obtain proper cover alignment.



5. Lubricate the crank stub, damper hub I.D. and the seal rubbing surface with clean engine oil or 50 weight oil only. DO NOT use grease on seal. Apply a 6mm (1/4-inch) bead of silicon rubber to inside of keyway of damper hub. Align the damper keyway with the key on the crankshaft and install the damper using Crankshaft Sprocket and Damper Replacer T52L-6306-AEE or equivalent.



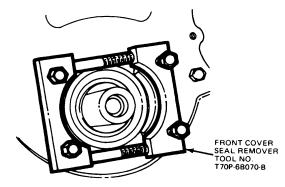
- Install the washer and capscrew. Tighten to 177-203 N·m (130-150 ft-lb).
- Install the pulley(s), drive belt, and fan as outlined. Refer to Section 03-05, Engine Accessory Drive.

- 8. Install the shroud, radiator, and hoses.
- Fill and bleed the cooling system. Use the specified antifreeze mix. Refer to Section 03-03, Engine Cooling. If foreign material has not entered the crankcase during the service work, it is not necessary to change the engine oil.
- Operate the engine at fast idle and check for coolant and oil leaks.

#### **Front Oil Seal**

#### Removal

- Remove the bolts attaching the fan shroud to the radiator.
- Remove the fan from the water pump shaft. Remove the fan and shroud.
- 3. Remove the drive belt from the engine.
- Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper and remove the vibration damper.
- Place the Front Cover Seal Remover T70P-6B070-B or equivalent onto the front cover plate over the front seal. Tighten the two through bolts to force the seal puller under the seal flange.



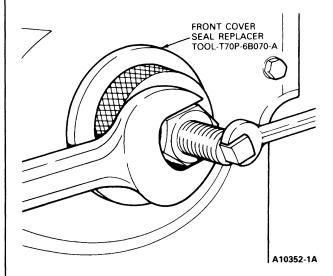
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 Alternately tighten the four puller bolts one half turn at a time. Pull the oil seal from the front cover.

#### Installation

 Coat a new front cover plate oil seal with CLEAN engine oil or 50 weight oil only. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.

 Place the installation screw, washer, nut and Tool T70P-6B070-A onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.



 Apply CLEAN engine oil or 50 weight oil only. DO NOT use grease to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply CLEAN engine oil or 50 weight oil only. DO NOT use grease to the front of the crankshaft for damper installation.

Apply a 6mm (1/4-inch) bead of silicone rubber to inside of keyway of damper hub. Install in five minutes.

- Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on crankshaft. Install the capscrew and washer. Tighten the screw to 95-122 N·m (70-90 ft-lb). Install the crankshaft pulley.
- 5. Install the drive belt.
- Position the fan shroud over the water pump pulley. Install the fan and spacer. Install the fan shroud attaching screws.

#### Oil Pan

# F-150 — F-350 and Bronco

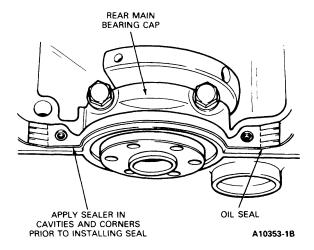
#### Removal

Drain the crankcase and the cooling system.

- Remove the upper intake and throttle body assembly.
- Raise the vehicle on a hoist. Disconnect the starter cable at the starter and remove the attaching bolts and starter.
- 4. Remove the engine front support insulator-to-support bracket nuts and washers on both supports. Raise the front of the engine with a transmission jack and wood block and place 25.4mm (1-inch) thick wood blocks between the front support insulators and support brackets. Lower the engine and remove the transmission iack
- 5. Remove the oil pan attaching bolts and lower the pan to the crossmember. Remove the two oil pump bolts and the one oil pump inlet tube nut, and drop the assembly in the oil pan. Remove the oil pan. Remove the oil pan gasket. Remove the inlet tube and screen from the oil pan.

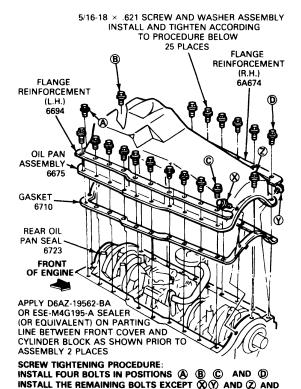
#### Installation

- Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Clean the seal grooves.
- Apply a pressure sensitive silicone based adhesive (such as G.E., Dow, Loctite or equivalent) to block rails and front cover oil pan.
- Apply a bead of RTV Silicone Rubber D6AZ-19562 AA or BA (ESE-M4G195-A) or equivalent (2 places) to parting line between front cover and block. Also (2 places) to tapered ends of rear seal portion of gasket. Immediately install gasket to block to facilitate pan installation.



 Clean the inlet tube and screen assembly and place it in the oil pan.

5. Position the oil pan under the engine. Install the inlet tube and screen assembly on the oil pump with a new gasket. Tighten the two screws to 14-20 N·m (10-15 ft-lb) and one nut to 30-43 N·m (22-32 ft-lb). Position the oil pan against the cylinder block and install stiffener (reinforcement) plates and the attaching bolts. Tighten the bolts in sequence to 16-24 N·m (144-216 in-lb).



 Raise the engine with a transmission jack and remove the wood blocks from the engine front supports. Lower the engine until the front support insulators are positioned on the support brackets. Install the washers and nuts on the insulator studs and tighten the nuts to 73-100 N·m (54-74 ft-lb).

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TIGHTEN SIMULTANEOUSLY TO 20-24 N·m (15-18 FT-LB) INSTALL BOLTS 

AND AND LAST AND TIGHTEN TO 20-24 N·m (15-18 FT-LB).

- 7. Install the starter and connect the starter cable.
- 8. Lower the vehicle. Install the radiator. Refer to Section 03-03, Engine Cooling.
- Install the upper intake and throttle body assembly.
- Fill the crankcase and cooling system. Refer to Section 03-03, Engine Cooling.
- Start the engine and check for coolant and oil leaks.

#### E-150-E-350

#### Removal

- Remove engine cover.
- Remove air cleaner. Disconnect the air inlet tubes from the throttle body.
- If vehicle is equipped with air conditioning, discharge the refrigerant from the system and remove compressor. Refer to Section 12-03, Air Conditioning General Service in the Body / Chassis / Electrical Manual.
- Remove the EGR valve.
- Remove the upper intake and throttle body assembly.
- Disconnect Thermactor check valve inlet hose and remove check valve.
- 7. Remove upper radiator hose.
- 8. Unbolt fan shroud and remove, or position the shroud on the fan.
- If vehicle has automatic transmission, remove transmission fill tube.
- 10. Remove exhaust inlet pipe-to-manifold nuts.
- Raise vehicle on hoist and disconnect fuel pump inlet hose. Plug the line.
- Remove front engine support nuts.
- 13. Remove power steering return line clip located in front of the No. 1 crossmember.
- Disconnect lower radiator hose and transmission cooler lines.
- 15. Remove the starter.
- Raise the engine and place a 76mm (3-inch) block under the engine mounts. Remove the oil pan dipstick tube from the oil pan.
- Remove oil pan bolts and the pickup tube and screen from the oil pump. Remove the pan.
- Clean oil pan, tube and screen assembly, seal groove and the gasket surfaces of the block and oil pan.

#### Installation

- Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Clean the seal grooves.
- Apply a pressure sensitive silicone based adhesive (such as G.E., Dow, Loctite or equivalent) to block rails and front cover oil pan.
- Apply a bead of RTV Silicone Rubber D6AZ-19562-AA or BA (ESE-M4G195-A) or equivalent (2 places) to parting line between front cover and block. Also (2 places) to tapered ends of rear seal portion of gasket. Immediately install gasket to block to facilitate pan installation.
- Clean the inlet tube and screen assembly and place it in the oil pan.

- 5. Position the oil pan under the engine. Install the inlet tube and screen assembly on the oil pump with a new gasket. Tighten the two screws to 14-20 N·m (10-15 ft-lb) and one nut to 30-43 N·m (22-32 ft-lb). Position the oil pan against the cylinder block and install stiffener (reinforcement) plates and the attaching bolts, shown under F-150—F-350 and Bronco, Installation. Tighten the bolts in sequence to 16-24 N·m (144-216 in-lb).
- Install the dipstick tube and lower the engine.
- Install the support nuts.
- 8. Install the starter and connect the fuel line.
- Install lower radiator hose and transmission cooler lines.
- Install the power steering return line clip and position the line.
- 11. Lower the hoist.
- Install the upper intake and throttle body assembly.
- 13. Install the EGR valve. Connect the exhaust.
- 14. Install Thermactor check valve and connect inlet hose (E-250HD or E-350 only).
- Install fan shroud and upper radiator hose.
   Replace engine coolant. Refer to Section 03-03, Engine Cooling.
- Install A/C compressor and charge system.
   Refer to Section 12-03, Air Conditioning General Service in the Body/Chassis/Electrical Manual.
- 17. Replace the oil filter and fill the crankcase. Start the engine and check for leaks.
- Install air cleaner and air inlet tubes. Install engine cover.

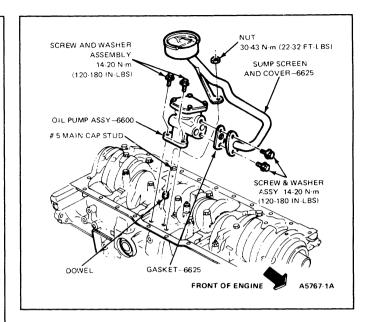
# Oil Pump

#### Removal

- Remove the oil pan following the procedures under Oil Pan Removal.
- Remove the oil pump attaching bolts and oil pump inlet tube nut. Then, remove the pump assembly.

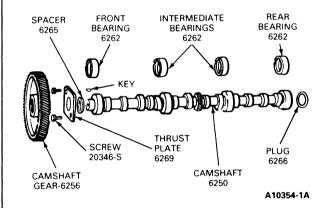
# Installation

- Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.
- 2. Install the oil pump on the cylinder block. Tighten the attaching bolts and nuts to specifications.
- Install the oil pan following the procedures under Oil Pan Installation.



#### Camshaft

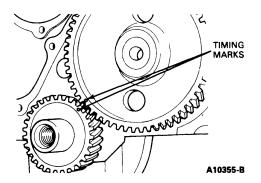
The camshaft and related parts are shown in the following illustration.



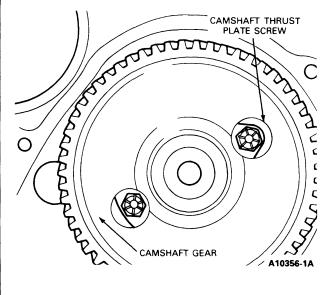
#### Removal

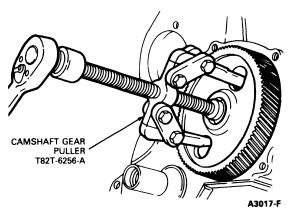
- 1. Drain the cooling system and the crankcase.
- Remove the shroud and radiator, valve tappets and cylinder front cover, following the procedures given in this section and Section 03-03, Engine Cooling.
- Disconnect primary wire at the coil. Remove the distributor following the procedure in Section 03-07, Ignition System General Service for breakerless ignition systems.
- Check the camshaft end play, the timing gear backlash and the timing gear runout. Refer to Section 03-00, Engine, Gasoline—General Service.

Turn the crankshaft to align the timing marks as shown.



Remove the camshaft thrust plate screws.
 Remove the camshaft gear using Camshaft Gear
 Puller T82T-6256-A or equivalent, as shown.
 Remove the key, thrust plate and spacer.
 Remove the camshaft. Avoid damaging the camshaft bearings lobes during removal.

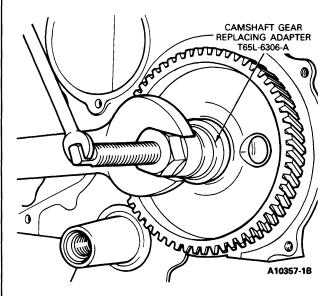




#### Installation

If the camshaft end play, timing gear backlash and/or timing gear runout were excessive, make the necessary corrections before installing the camshaft.

- Oil the camshaft bearing journals and apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to all the lobes.
- Assemble key, spacer and thrust plate to camshaft. Align the gear keyway with the key and install the gear on the camshaft using Camshaft Gear Replacing Adapter T65L-6306-A or equivalent.



- Install the camshaft, gear and thrust plate as an assembly, making sure that the timing marks are in alignment. Use care to avoid bearing damage.
- Tighten the thrust plate attaching screws to 13-16 N·m (9-12 ft-lb).
- Crank the engine until the timing marks are aligned. Do not turn the crankshaft again until the distributor is installed.
- 6. Clean the cylinder front cover and cylinder block gasket surfaces. Install a new oil seal in the cylinder front cover if necessary. Clean the crankshaft damper and inspect it. Refer to Section 03-00, Engine, Gasoline—General Service. Install the cylinder front cover and damper, valve tappets and radiator, following the installation procedures given in this section and Section 03-03, Engine Cooling.

Install the distributor. Refer to Section 03-07, Ignition System General Service. With the rotor at No. 1 firing position, align the stator armature tooth exactly with the armature tooth prior to tightening the hold-down clamp.

- 7. Fill the crankcase and cooling system. Refer to Section 03-03, Engine Cooling.
- 8. Start the engine and check for oil, coolant and fuel leaks. Adjust the ignition timing.

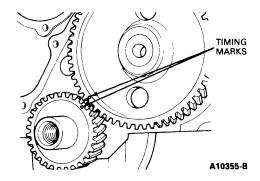
#### **Timing Gears**

To prevent possible damage to the camshaft lobes, do not rotate the camshaft or crankshaft in the engine without the timing gears installed.

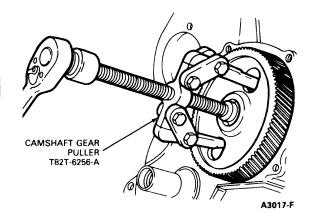
#### **Camshaft Gear**

#### Removal

- 1. Drain the cooling system and crankcase.
- 2. Remove the cylinder front cover following the procedures under Cylinder Front Cover Removal.
- Check the camshaft end play, the timing gear backlash and the timing gear runout. Refer to Section 03-00, Engine, Gasoline—General Service.
- Crank the engine until the timing marks are aligned as shown.



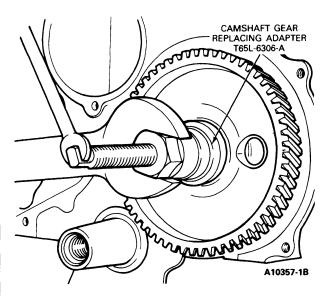
 Install the Camshaft Gear Puller T82T-6256-A or equivalent as shown and remove the camshaft gear.



#### Installation

If the camshaft end play, timing gear backlash and/or timing gear runout were excessive, make the necessary corrections before installing the gear.

 Ensure the key spacer and thrust plate are properly installed. Align the gear keyway with the key and install the gear on the camshaft using Camshaft Gear Replacing Adapter T65L-6306-A or equivalent. Ensure that the timing marks line up on the camshaft and crankshaft gears.

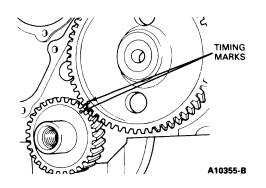


- Install the cylinder front cover and related parts following the procedures under Cylinder Front Cover Installation.
- Fill the crankcase and cooling system. Refer to Section 03-03, Engine Cooling. Start the engine and adjust the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

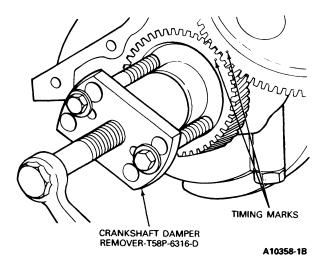
### Crankshaft Gear

#### Removal

- Drain the cooling system and crankcase. Remove the radiator. Refer to Section 03-03, Engine Cooling.
- 2. Remove the cylinder front cover.
- Crank the engine until the timing marks are aligned.

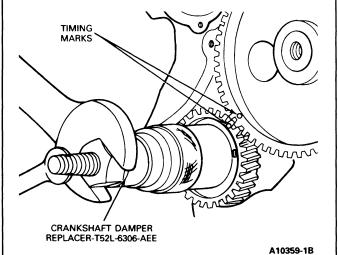


 Use Crankshaft Damper Remover T58P-6316-D or equivalent and remove the crankshaft gear. Remove the key from the crankshaft.



#### Installation

Install the key in the crankshaft keyway. Install
the crankshaft gear using the Crankshaft Damper
Replacer T52L-6306-AEE or equivalent. Ensure
timing marks are aligned properly on the
camshaft and crankshaft gears. Install the oil
slinger.



- Replace the crankshaft front oil seal. Install the cylinder front cover following the procedures under Cylinder Front Cover.
- 3. Install the radiator. Refer to Section 03-03, Engine Cooling.
- Fill the crankcase and the cooling systems. Refer to Section 03-03, Engine Cooling. Start the engine and check all gaskets and hose connections for leaks. Adjust the ignition timing and curb idle to the specifications on the engine decal.

# **Flywheel**

#### Removal

- Remove the transmission following the procedure in Section 07-00B (Clutch and Manual Transmission) or Section 07-00A (Automatic Transmission).
- On a manual transmission, remove the clutch pressure plate and cover assembly and clutch disc following the procedure in Section 07-00B.
- 3. Remove the flywheel attaching bolts and remove the flywheel.

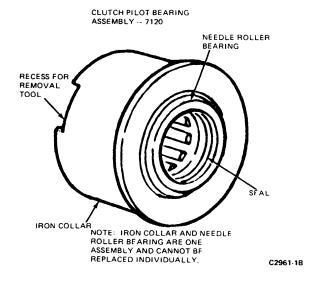
To check flywheel face runout or replace the flywheel ring gear, refer to Section 03-00, Engine, Gasoline—General Service.

### Installation

- Position the flywheel on the crankshaft flange. Coat the threads of the flywheel attaching bolts with oil-resistant sealer and install the bolts. Tighten the bolts in sequence across from each other to 102-115 N·m (75-85 ft-lb).
- On a manual transmission, install the clutch disc and the pressure plate and cover assembly. Refer to Section 07-00B.
- Install the transmission. Refer to Section 07-00A or 07-00B.

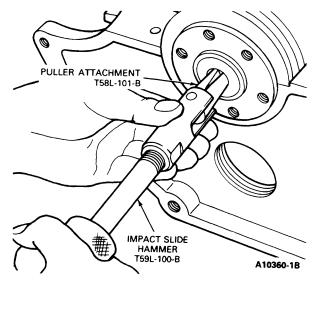
# **Clutch Pilot Bearings**

A needle roller bearing and adaptor assembly is used as a clutch pilot bearing on E-150—E-350, F-150—F-350, and Bronco vehicles. It is inserted directly into the engine crankshaft. The bearing and adaptor assembly cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pregreased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed. For additional information refer to Section 08-01, Clutch.



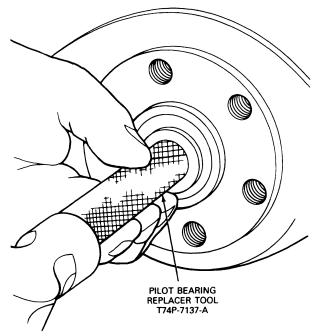
#### Removal

- Remove the transmission, clutch pressure plate, and disc. Refer to Section 07-00B.
- Using the Impact Slide Hammer T59L-100-B and Puller Attachment T58L-101-AB or equivalents, remove the pilot bearing.



#### Installation

 Using Pilot Bearing Replacer T74P-7137-A or equivalent, install the pilot bearing with the seal facing the transmission so that the adaptor is not cocked.



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 Install the clutch pressure plate, disc, and transmission. Refer to Section 07-00B.

NOTE: Care must be taken not to damage the bearing while the transmission input shaft is being inserted into the bearing during transmission installation.

# **Camshaft Rear Bearing Bore Plug**

#### Removal

- Remove the transmission and flywheel housing. Refer to Section 07-00B (Manual Transmission) or Section 07-00A (Automatic Transmission). On a manual transmission, remove the clutch pressure plate and disc. Refer to Section 08-01.
- Remove the flywheel attaching bolts. Remove the flywheel and the engine rear cover plate.
- 3. Refer to Section 03-00, Engine, Gasoline General Service to remove the core plug.

### Installation

 Replace the core plug. Refer to Section 03-00, Engine, Gasoline—General Service.

Install the engine rear cover plate and flywheel.
Coat the flywheel attaching bolts with Pipe
Sealant with Teflon® D8AZ-19554-A
(ESG-M4G194-A) or equivalent. Tighten the
flywheel bolts in sequence to 102-115 N·m
(78-85 ft-lb).

On a vehicle with a manual transmission, install the clutch pressure plate and disc and transmission. Refer to Section 07-00B.

On a vehicle with an automatic transmission, install the transmission and converter housing. Refer to Section 07-00A.

#### **Crankshaft Rear Oil Seal**

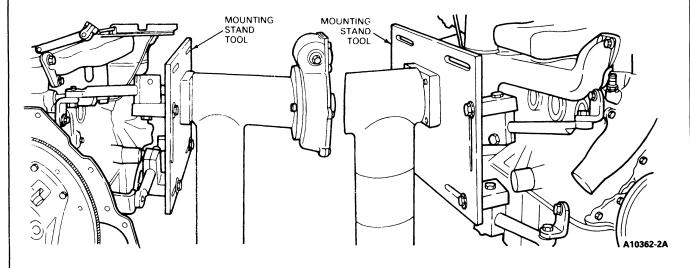
For crankshaft rear oil seal replacement refer to One-Piece Rear Oil Seal, Removal and Installation in Section 03-00, Engine, Gasoline—General Service.

#### Main Bearing

Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.

Bearings are available for service in standard sizes or .010 and .020 inch undersize. Refer to the Parts Catalog for the available sizes. Undersize bearings are available for use on journals that have been refinished.

If the rear main bearing is to be replaced, it will be necessary to remove the engine, install it on a work stand, replace the main bearing and replace the crankshaft rear oil seal.

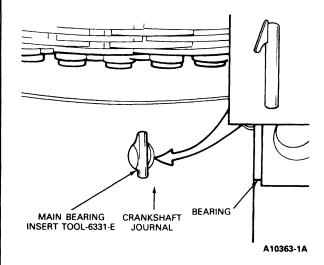


#### Removal

- Drain the crankcase. Remove the oil pan and oil pump following the procedure under Oil Pan Removal.
- Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.

NOTE: Loosen all main bearing caps until finger-tight. This will lower the crankshaft and ease installation of new bearings.

3. Insert Main Bearing Insert Tool TOOL-6331-E in the oil hole in the crankshaft journal.



- Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
- Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with standard bearings or a combination of a standard bearing and a .010 or .020 inch undersize bearing.

#### Installation

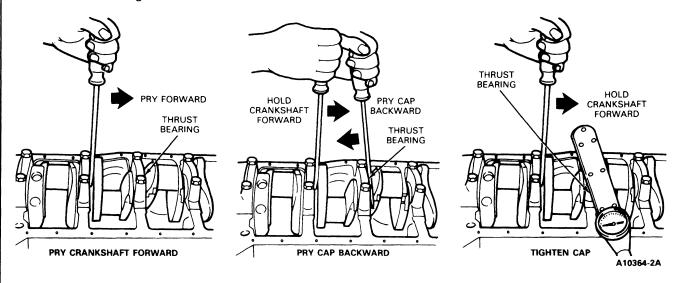
 The upper and lower bearing halves are not interchangeable. The upper half is drilled and grooved to provide entry of oil. Be sure bearings and surfaces are clean. Foreign material under the inserts will distort the bearings and cause failure.

To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that Main Bearing Insert Tool TOOL-6331-E can be inserted in the oil hole in the crankshaft journal. With Main Bearing Insert Tool TOOL-6331-E positioned in the oil hole, rotate the crankshaft slowly in the opposite direction of engine rotation until the bearing is seated. Remove the tool.

Select-fit the bearing for proper clearance. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00, Engine, Gasoline—General Service.

- After the bearing has been fitted, apply a light coat of engine oil to the journal and bearings. Then, install the bearing cap. Tighten the cap bolts to 82-94 N-m (60-70 ft-lb).
- 3. Repeat the procedure for the remaining bearings that require replacement.
- 4. If the thrust bearing cap (No. 5 main bearing) has been removed, install it as follows:

Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Tighten the cap bolts to 82-94 N-m (60-70 ft-lb).



- 5. If the rear main bearing is replaced (on a work stand), clean the mating surfaces of the bearing cap and the block with Ford Extra-Strength Spot and Stain Remover B7A-19521-AA (ESR-M5B197-A) or equivalent solvent. Apply a 1.6mm (1/16 inch) bead of RTV sealer, Silicone Rubber D6AZ-19562-BA (ESE-M4G195-A) or equivalent in each corner of the rear main bearing cap saddle the full length of the saddle. Be sure the main bearing is fitted and the cap bolts tightened to 82-94 N·m (60-70 ft-lb) before installing the new crankshaft rear oil seal.
  - NOTE: When applying RTV sealant, always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.
- Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until the oil emerges from the outlet opening.
- Install the oil pump and oil pan following the procedure under Oil Pan Installation.
- Fill the crankcase and cooling system. Refer to Section 00-03, Maintenance and Lubrication. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

# **Connecting Rod Bearing**

#### Removal

- Drain the crankcase. Remove the oil pan and oil pump following the procedure under Oil Pan Removal.
- Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.
  - NOTE: If bearings are to be reused, identify them according to location so that they can be installed in their original positions.
- Ensure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.
- 4. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with standard bearings. Refer to Section 03-00, Engine, Gasoline—General Service for the cleaning and inspection procedures.

#### Installation

 Install the bearing inserts in the connecting rod and cap with the tangs fitted in the slots.

- 2. Pull the connecting rod assembly down firmly on the crankshaft journal.
  - Fit the bearing. Refer to Section 03-00, Engine, Gasoline—General Service.
- After the bearing has been fitted, clean and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap and tighten the nuts to 55-61 N·m (40-45 ft-lb).
- Repeat the procedure for the remaining connecting rods that require new bearings.
- Install the oil pan and oil pump following the procedures under Oil Pan Installation in this section.
- Fill the crankcase. Fill the cooling system. Refer to Section 03-03, Engine Cooling. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

# **Pistons and Connecting Rods**

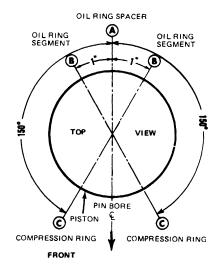
#### Removal

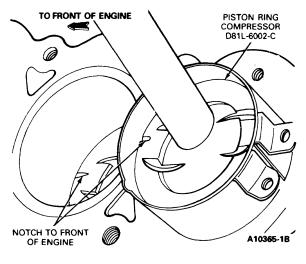
- Drain the cooling system and the crankcase. Refer to Section 03-03, Engine Cooling.
- Refer to Cylinder Head Removal in this section and remove the cylinder head and related parts.
- Remove the oil pan following the procedure under Oil Pan Removal in this section. Remove the oil pump inlet tube and the oil pump.
- 4. Turn the crankshaft until the piston to be removed is at the bottom of the stroke and place a cloth on the piston dome to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore with Cylinder Ridge Reamer T64L-6011-EA or equivalent. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 0.74mm (1/32 inch) when removing ridges.
- Ensure all the connecting rod caps are marked so that they can be installed in their original positions. Remove the connecting rod cap.
- Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

#### Installation

- Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.
- Oil the piston rings, pistons and cylinder walls with light engine oil.

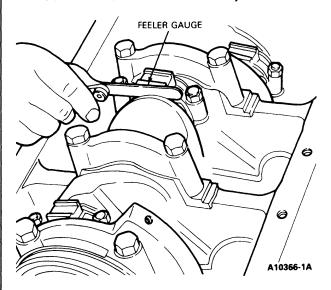
- 3. Ensure pistons are installed in the same cylinders from which they were removed or to which they were fitted. The connecting rods and bearing caps are numbered from 1 to 6 beginning at the front of the engine. The number on the connecting rod and bearing cap must be on the same side of rod when installing in the cylinder bore. If a connecting rod is ever transferred from one cylinder block to another or from one cylinder to another, new bearings should be fitted and the connecting rod should be re-numbered to correspond with the new cylinder number.
- 4. Make sure the ring gaps (oil ring spacer -A, oil ring segment -B, and compression ring -C) are properly spaced around the circumference of the piston. Oil the rings, then install Piston Ring Compressor D81L-6002-C or equivalent on the piston. Make sure that the indentation in the dome of piston is toward the front. Then, push the piston into its bore with the handle end of a hammer until it is slightly below the top of the cylinder. Be sure to guide the connecting rods to avoid damaging the crankshaft journals.





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- Check the clearance of each bearing following the procedure under Fitting Main or Connecting Rod Bearing in Section 03-00, Engine, Gasoline—General Service.
- After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
- Turn the crankshaft throw to the bottom of its stroke. Then, push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Tighten the nuts to 55-61 N·m (40-45 ft-lb).
- After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal.



- Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the oil pump inlet tube. Install the oil pan and related parts as outlined.
- Refer to Cylinder Head Installation and install the cylinder head and related parts. Adjust the valve clearance as outlined.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase.
- Start the engine and check for oil pressure.
   Operate the engine at fast idle and check for oil and coolant leaks.
- Operate the engine until engine temperatures have stabilized. Check and adjust the ignition timing.

On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05, Shift Control Linkage.

#### Oil Filter

#### Removal

 Place a drip pan under the oil filter. Unscrew the filter from the cylinder block using Oil Filter wrench D79L-6731-A, B or equivalents.

#### Installation

- Coat the gasket on the filter with oil. Place the filter in position on the cylinder block.
   Hand-tighten the filter until the gasket contacts the adapter face, then advance it one-half turn.
- Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase if necessary.

#### **REMOVAL AND INSTALLATION**

# **Engine Assembly**

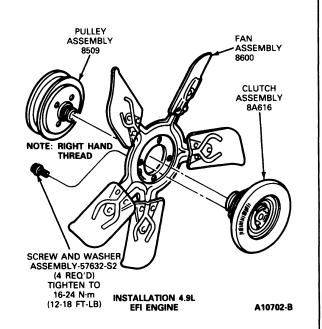
#### F-150 — F-350 and Bronco

The engine removal and installation procedures are for the engine only without the transmission attached.

#### Removal

- Drain the cooling system and the crankcase. Remove the hood. Remove the throttle body inlet tubes.
- Disconnect the battery ground cable. Disconnect the heater hose from the water pump and coolant outlet housing. Disconnect the flexible fuel line from the fuel pump.
- 3. Remove the radiator and shroud. Refer to Section 03-03, Engine Cooling.
- 4. Remove the cooling fan, viscous fan drive, water pump pulley and fan drive belt.

NOTE: The fan clutch/water pump hub has a RH thread.



Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring.

Disconnect power brake vacuum line at the intake manifold.

On a vehicle with an automatic transmission, disconnect the transmission kickdown cable at the throttle body.

- Disconnect the exhaust manifold from the muffler inlet pipe. Disconnect the body ground strap and the battery ground cable at the engine.
- Disconnect the Electronic Engine Control (EEC) harness from all sensors.
- Disconnect the engine wiring harness at the ignition coil, coolant temperature sending unit and oil pressure sending unit. Position the harness out of the way.
- Remove the alternator mounting bolts and position the alternator out of the way, leaving the wires attached.

Remove the power steering pump from the mounting brackets and position it right side up and to one side, leaving the lines attached. If equipped with an air compressor, bleed the air system and disconnect the two air pressure lines at the compressor.

 Raise the vehicle. Remove the starter (and the automatic transmission fluid filler tube bracket). Remove the engine rear plate upper RH bolt.

On a vehicle with a manual transmission, remove all the flywheel housing lower attaching bolts. Disconnect the clutch slave cylinder.

On a vehicle with an automatic transmission, remove the converter housing access cover assembly. Remove the flywheel-to-converter nuts and secure the converter assembly in the housing. Remove the transmission oil cooler lines from the retaining clip at the engine. Remove the converter housing-to-engine lower attaching bolts.

- 11. On F-150—F-350 and Bronco, remove the insulator-to-intermediate support bracket nut from each engine front support.
- Lower the vehicle and position a transmission jack, such as Rotunda 066-00017 or equivalent, under the transmission to support it. Remove the remaining flywheel or converter housing-to-engine bolts.
- Attach Engine Lifting Bracket T70P-6000, Rotunda Engine Sling 014-00036, or equivalent. Raise the engine slightly and carefully pull it from the transmission. Lift the engine out of the chassis.

#### Installation

 Lower the engine carefully into the chassis. Make sure the dowels in the block engage the holes in the flywheel or converter housing.

On a vehicle with an automatic transmission, start the converter pilot into the crankshaft. Remove the retainer securing the converter in the housing.

On a vehicle with a manual transmission, start the transmission input shaft into the clutch disc. It may be necessary to adjust the position of the transmission with relation to the engine if the transmission input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (with the transmission in gear) until the shaft splines mesh with the clutch disc splines.

- Install the converter or flywheel housing upper attaching bolts. Remove the jack supporting the transmission.
- 3. Lower the engine until it rests on the engine support(s) and remove the lifting sling.
- Install the engine LH and RH, support insulator-to-intermediate support bracket attaching nuts and washers. Tighten the nuts to 73-100 N·m (54-74 ft-lb). Install the automatic transmission oil cooler lines bracket.
- Install the remaining converter or flywheel housing attaching bolts. Connect the clutch return spring.
- Install the starter and connect the starter cable. Attach the automatic transmission fluid filler tube bracket, if so equipped.

On a vehicle with an automatic transmission, install the transmission oil cooler lines in the bracket at the cylinder block.

- Install the exhaust manifold-to-muffler inlet pipe lockwashers and nuts. Tighten the nuts to specification. Refer to Section 09-00, Exhaust System.
- 8. Connect the engine ground strap and the battery ground cable.
- Connect Electronic Engine Control (EEC) harness to all sensors.
- 10. On a vehicle with an automatic transmission, connect the kickdown cable to the throttle body.

Connect the accelerator linkage to the throttle body and install the retracting spring.

Reconnect power brake vacuum line to the intake manifold.

- Connect the coil primary wire, oil pressure and coolant temperature sending unit wires, flexible fuel line, heater hoses and the battery positive cable.
- 12. Install the alternator on the mounting bracket.

Install power steering pump on the mounting brackets. Tighten the alternator, power steering pump and air compressor mounting bolts to specification. Refer to Section 03-05, Engine Accessory Drive.

13. Install the water pump pulley, viscous fan drive, cooling fan and drive belt. Tighten the fan bolts to 16-24 N·m (12-18 ft-lb).

NOTE: The fan clutch / water pump hub has a RH thread.

14. Install the radiator and shroud. Connect the radiator lower hose to the water pump and the radiator upper hose to the coolant outlet housing. Connect the air compressor lines. If removed, install air conditioner compressor and condenser.

On a vehicle with an automatic transmission, connect the oil cooler lines.

- 15. If applicable, install and adjust the hood.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.
- Perform EEC Quick Test to check the function of the EEC system, if so equipped. Refer to Engine / Emissions Diagnosis\* manual.
- On a vehicle with a manual transmission, check for correct clutch operation.

On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05, Shift Control Linkage. Check the fluid level and add as required to bring it to the proper level on the oil indicator.

19. Install the throttle body intake tubes.

#### E-150-E-350

#### Removal

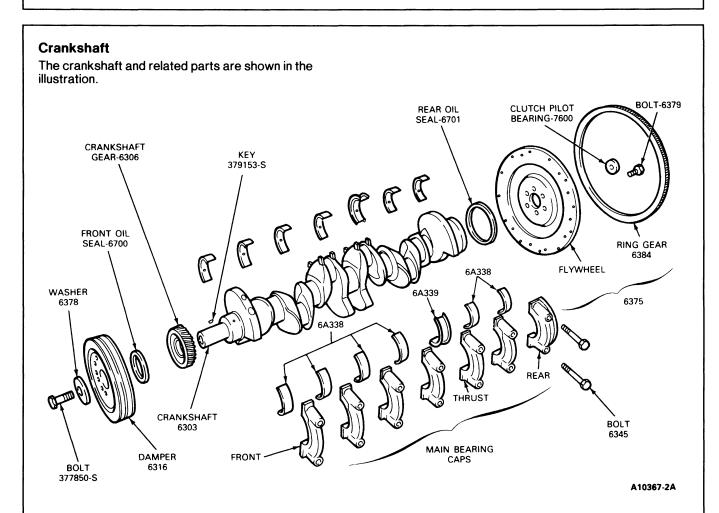
- Open the hood and door and install seat covers.
   Then, remove the engine cover, drain the coolant, remove the air cleaner and disconnect the battery.
- Remove the front bumper. Then, remove the grille and lower gravel deflector as an assembly.
- Disconnect the upper radiator hose at the radiator.
- Remove the lower radiator hose at the radiator.
- Disconnect the transmission oil cooler lines at the radiator, if so equipped.
- 6. Remove the radiator and the shroud.
- 7. Disconnect the heater hoses at the engine.
- 8. Disconnect the alternator and move aside.
- Remove the drive belt. Then, remove the power steering pump and support from the engine and move aside.
- 10. Disconnect the fuel line at the fuel rail and plug it.
- Disconnect the distributor and sender unit wires from the engine.
- Disconnect the Electronic Engine Control (EEC) harness from all sensors.
- 13. Disconnect the brake booster hose at the engine.
- Disconnect the accelerator cable and remove the bracket from the engine.
- Disconnect the automatic transmission kickdown cable at the throttle body.
- 16. Remove the exhaust manifold heat deflector. Then, remove the inlet pipe-to-manifold nuts.
- 17. Disconnect both ends of the transmission vacuum line from the intake manifold and junction.
- Remove the upper transmission-to-engine bolts.
- Remove the automatic transmission dipstick tube support bolt at the intake manifold.
- Raise the vehicle on a hoist and drain the crankcase.
- Disconnect the wires from the starter and remove the starter.
- 22. Remove the flywheel inspection cover.
- 23. Remove the four converter nuts, then remove the front engine support nuts.
- 24. Remove the oil filter.
- 25. Complete the removal of the engine-to-transmission nuts.
- 26. Lower the vehicle.

27. Install the lift chain and remove the engine from the engine compartment.

#### Installation

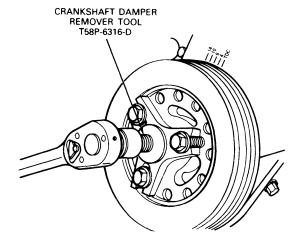
- Position the engine and lower into place. Then, start the mounting bolts.
- Remove the lifting chain and connect the exhaust inlet to the manifold.
- 3. Connect the transmission dipstick tube, if so equipped, to the intake manifold.
- 4. Install the manifold heat shield.
- Connect the automatic transmission kickdown cable, then install the upper transmission-to-engine bolts.
- Connect the transmission vacuum line at the junction.
- Install the accelerator cable and bracket assembly.
- 8. Connect the distributor and sender unit wires to the engine.
- 9. Connect the brake booster hose.
- 10. Unplug and connect the fuel line to the fuel rail.
- Connect the transmission vacuum line to the manifold.
- 12. Install the alternator wires.
- 13. Connect the heater hoses to the engine.
- Install the power steering pump and support bracket.
- 15. Install the drive belt. Refer to Section 03-05, Engine Accessory Drive.
- 16. Install the radiator and shroud assembly.
- 17. Position the grille and lower gravel deflector.
- 18. Connect the upper radiator hose, then install the grille and deflector bolts and screws.
- Install the bumper, then raise the vehicle on a hoist.
- 20. Install the converter nuts, then install the flywheel inspection cover bolts.
- Connect the starter wires and install the starter assembly.
- 22. Install the oil filter.
- Install the front support nuts, and the lower engine-to-transmission bolts. Tighten to 82-108 N-m (60-80 ft-lb).
- 24. Connect the lower radiator hose.
- Connect the transmission cooler lines to the radiator.
- 26. Install the alternator splash shield.
- 27. Lower the vehicle.

- 28. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Connect the battery and fill the crankcase with the proper grade of oil.
- 29. Perform the EEC Quick Test to check the function of the EEC system. Refer to the Engine / Emissions Diagnosis\* manual.
- 30. Start the engine and check for leaks. Then, install the engine cover and close the hood and door.



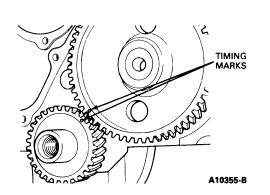
#### Removal

- Install the engine on a work stand. Remove the spark plugs to allow easy rotation of the crankshaft. Drain the crankcase.
- 2. Remove the oil level dipstick.
- Remove the crankshaft damper attaching bolt and lockwasher. Remove the crankshaft damper.



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- 4. Remove the cylinder front cover and gasket.
- 5. Remove the flywheel and engine rear cover plate.
- Turn the engine on the work stand so that the bottom of the engine is up. Remove the oil pan, gaskets and seals. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.
- 7. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is at the bottom of the stroke. Remove the connecting rod cap and bearings. Push the connecting rod and piston assembly up in the cylinder. Do not turn the crankshaft completely around as the rod bolts may damage the crankpin journals. Repeat this procedure and remove all connecting rod caps.
- 8. Remove the clutch pilot bearing if necessary.
- Align the timing marks. Remove the crankshaft gear as outlined.



- Remove the main bearing caps and bearings and rear bearing seal.
- 11. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

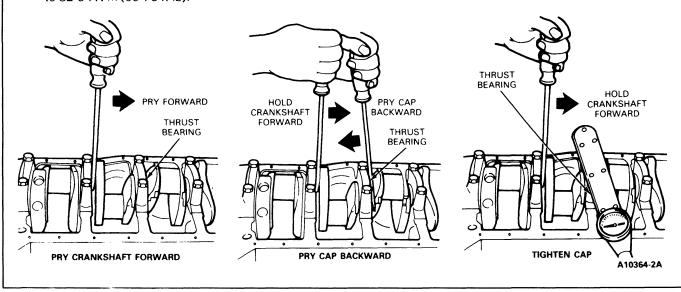
Refer to Section 03-00, Engine, Gasoline — General Service for the cleaning and inspection procedures. Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.

To refinish journals and dress minor imperfections, refer to Section 03-00, Engine, Gasoline — General Service.

#### Installation

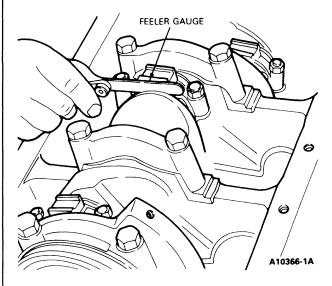
- Remove the main bearing inserts from the block and bearing caps.
- Remove the bearing inserts from the connecting rod caps.
- 3. Clean the crankshaft rear oil seal recess in the cylinder block and rear main bearing cap.
- 4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.
- Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.
   Be sure the oil holes in the bearing inserts are aligned with the oil holes in the cylinder block.
- Install the lower main bearing inserts in the bearing caps with the tang fitted in the slot.
- 7. Carefully lower the crankshaft into place. **Be** careful not to damage the bearing surfaces.
- Check the clearance of each main bearing. Refer to Section 03-00, Engine, Gasoline—General Service under Fitting Main and Connecting Rod Bearings. Seal the rear main bearing-to-block mating surfaces as directed in Main Bearing Installation.

- 9. After the bearings have been installed, apply a light coat of heavy engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). Be sure that the main bearing caps are installed in their original locations. Tighten the bearing cap bolts to 82-94 N·m (60-70 ft-lb).
- Install the thrust bearing cap with the bolts finger-tight.
- 11. Pry the crankshaft forward against the thrust surface of the upper half of the bearing.



- 12. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.
- Retain the forward pressure on the crankshaft.
   Tighten the cap bolts to 82-94 N·m (60-70 ft-lb).
- 14. Check the crankshaft end play. Refer to Section 03-00, Engine, Gasoline—General Service.
- 15. If the end play exceeds the service limit, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks or foreign matter. If the thrust faces are not damaged or dirty, they probably need re-aligning. Install the thrust bearing and align the faces following the recommended procedure (steps 10 through 13 above). Then, check the end play.
- 16. Coat a new crankshaft rear oil seal with oil and install using Rear Oil Seal Replacer T65P-6701-A or equivalent. Refer to One-Piece Rear Oil Seal Installation in Section 03-00, Engine, Gasoline General Service. Inspect the seal to be sure it was not damaged during installation.
- 17. Install the bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.
- If the bearing clearances are to specifications, apply a light coat of engine oil to the journals and bearing.

- 19. Turn the crankshaft throw to the bottom of its stroke and pull the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
- Install the connecting rod cap and tighten the nuts to specifications.
- 21. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal. Refer to Specifications.

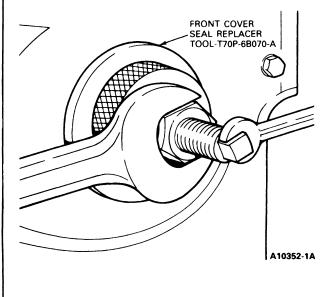


22. Clean the oil pan, oil pump and oil pump screen.

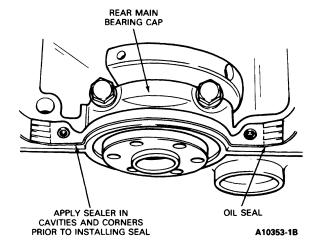
- 23. Install the inlet tube and screen on the oil pump. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump. Tighten the attaching bolts to 14-20 N·m (10-15 ft-lb).
- On a crankshaft for a manual transmission, install the clutch pilot bearing. Refer to Clutch Pilot Bearing Removal and Installation.
- 25. Turn the engine on the work stand so that the rear of the engine is up. Position the engine rear cover plate on the cylinder block. Position the flywheel on the crankshaft. Coat the threads of the attaching bolts with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent oil-resistant sealer and install the bolts. Tighten the bolts to 102-115 N·m (75-85 ft-lb).

On a flywheel for a manual transmission, locate the clutch disc following the procedure in Section 07-00B. Install the pressure plate. Tighten the attaching bolts to 102-115 N·m (75-85 ft-lb).

- Turn the engine on the work stand so that the front end is up.
- Install the crankshaft gear following the procedure under Timing Gear Installation.
- 28. Install a new grease-coated crankshaft front oil seal in the cylinder front cover using Front Cover Seal Replacer T70P-6B070-A or equivalent. Install the cylinder front cover and crankshaft damper by following the procedure outlined under Cylinder Front Cover Installation.



29. Apply Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil-resistant sealer in the cavities between the rear bearing cap and cylinder block. Install a new seal in the rear main bearing cap and apply a bead of Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil-resistant sealer to the tapered ends of the seal. Install new side gaskets on the oil pan with Gasket and Trim Adhesive D7AZ-19B508-AA (ESE-M2G52-A) or equivalent oil-resistant sealer. Position a new oil pan-to-cylinder front cover seal on the oil pan and install the oil pan.



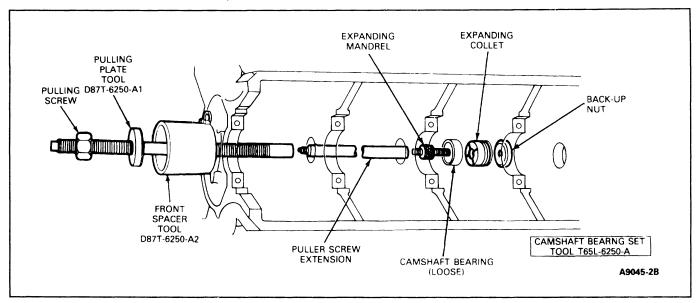
- 30. Install the oil level dipstick.
- Remove the engine from the work stand and install it in the vehicle. Fill the crankcase. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling.
- Start the engine and check all gaskets and hose connections for leaks.
- 33. Check the ignition timing and adjust to specifications on the engine decal.

## **Camshaft Bearings**

Camshaft bearings are available prefinished to size for standard and 0.381mm (0.015 inch) undersize journal diameters.

#### Removal

- 1. Remove the engine and install on a work stand.
- 2. Remove the camshaft, flywheel and crankshaft. Push the pistons to the top of the cylinders.
- Remove the camshaft rear bearing bore plug. Refer to Section 03-00, Engine, Gasoline—General Service. Remove the camshaft bearings with Camshaft Bearing Set T65L-6250-A or equivalent.



- 4. Select the proper size expanding collet and backup nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing and tighten the backup nut on the expanding mandrel until the collet fits the camshaft bearing.
- 5. Assemble the puller screw and extension, if necessary, as shown and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.
- To remove the front bearing, install the puller screw from the rear of the cylinder block.

#### Installation

- Position the new bearings at the bearing bores, and press them in place with Camshaft Bearing Set T65L-6250-A or equivalent. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. Failure to use the correct expanding collet can cause severe bearing damage. Align the oil holes in the bearings with the oil holes in the cylinder block before pressing bearings into place. Be sure the front bearing is installed 0.51-0.89mm (0.020-0.035 inches) below the front face of the cylinder block.
- Install the camshaft rear bearing bore plug. Refer to Section 03-00, Engine, Gasoline—General, Service.

- Install the camshaft, crankshaft, flywheel and related parts. Do not check connecting rod and main bearing clearances as a part of camshaft bearing replacement.
- 4. Install the engine in the vehicle.

#### DISASSEMBLY AND ASSEMBLY

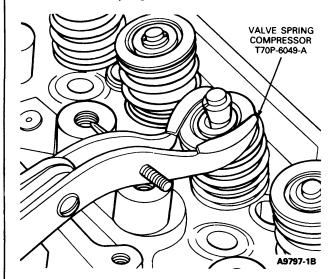
When installing nuts or bolts that must be tightened, oil the threads with light weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.** 

#### Cylinder Head

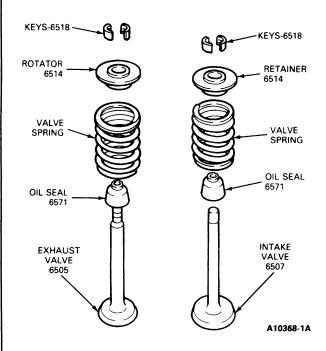
# Disassembly

- 1. Remove the coolant outlet housing and thermostat. Discard the gasket.
- Remove the upper intake and throttle body assembly.
- Remove the lower intake manifold and exhaust manifold from the cylinder head. Discard the gasket.
- 4. Remove the spark plugs.
- Remove the deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. Be careful not to scratch the cylinder head gasket surface.

 Compress the valve springs using Valve Spring Compressor T70P-6049-A or equivalent, then remove the valve spring retainer locks and release the spring.



7. Remove the spring retainer, spring, stem seal and valve. Discard the valve stem seals.

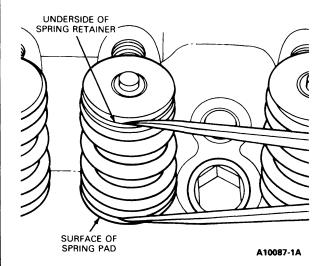


# Assembly

 Lubricate the valve guides and valve stems with heavy engine oil. Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the tip of the valve stems.

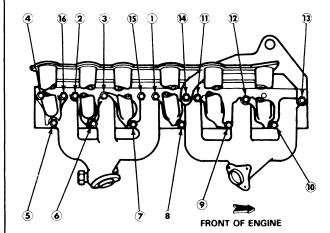
- Install each valve in the valve guide from which it was removed or to which it was fitted.
- 3. Oil and install a new stem valve oil seal.
- Install the valve spring over the valve. Ensure the closed coil end is placed against the cylinder head.
- Position the spring retainer on all valve springs.
   Make sure that a positive rotating retainer is used on all of the exhaust valves.
- Compress the spring. Install the keys. Tap the retainers after assembly to seat the keys.
- Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers.

Check the dividers against a scale. If the assembled height is greater than the specified limit, install the necessary 0.76mm (0.030-inch) thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension. Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.



 Position a new Intake Manifold Gasket on the cylinder head. Install the lower intake manifold and exhaust manifolds. Tighten the manifold bolts and nuts in sequence to 30-43 N·m (22-32 ft-lb)—intake manifold, 38-44 N·m (28-33 ft-lb)—exhaust manifold.

NOTE: Combination intake / exhaust gasket is not to be used on a new exhaust manifold. Gasketing of the exhaust manifold is only recommended when the original exhaust manifold is installed.



A10704-1A

- Install the upper intake and throttle body assembly.
- 10. Using a new gasket coated with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent water-resistant sealer, install the thermostat and coolant outlet elbow. Refer to Section 03-03, Engine Cooling. Tighten the attaching bolts to specifications.

## **Valve Tappet**

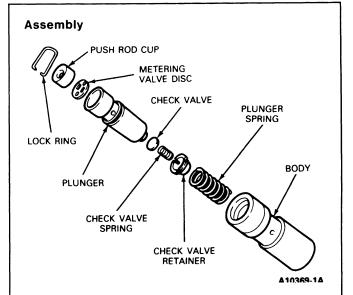
Valve tappets should always be tested after assembly. Refer to the test procedures in Section 03-00, Engine, Gasoline—General Service.

#### Disassembly

Each valve tappet is a matched assembly. If the parts of one tappet are mixed with those of another, improper valve operation may result. Disassemble and assemble each tappet separately. Keep the tappet assemblies in proper sequence so that they can be installed in their original bores.

- Grasp the lock ring with needlenose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.
- 2. Remove the push rod cup, metering valve (disc), plunger and spring.
- Invert the plunger assembly and remove the check valve retainer by carefully prying up on it with a screwdriver. Remove the check valve (disc or ball check) and spring.

For the cleaning and inspection procedures, refer to Section 03-00, Engine, Gasoline—General Service.

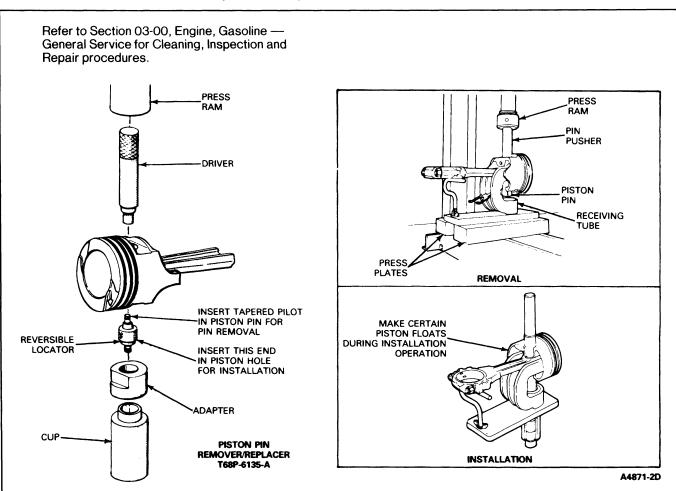


- Place the plunger upside down on a clean work bench.
- Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
- Position the check valve retainer over the check valve and spring. Push the retainer down into place on the plunger.
- Place the plunger spring and then the plunger (open end up) into the tappet body.
- Position the metering valve (disc) in the plunger and then place the push rod cup in the plunger.
- 6. Depress the plunger and position the closed end of the lock ring in the groove of the tappet body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger and then depress it again to fully seat the lock ring.
- Use the hydraulic valve tappet leakdown tester to fill the tappets with test fluid. Refer to Section 03-00, Engine, Gasoline—General Service.

# Piston and Connecting Rod

### Disassembly

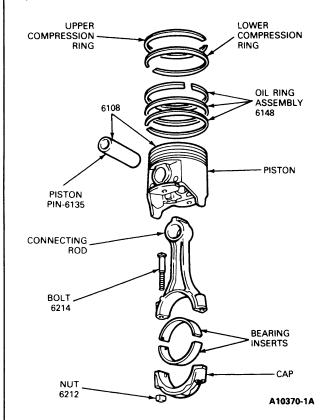
- Remove the bearing inserts from the connecting rod and cap.
- Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinder from which they were removed.
- Remove the piston rings. Using an arbor press and Piston Pin Remover / Replacer T68P-6135-A or equivalent, press the piston pin from the piston and connecting rod using Piston Pin Remover / Replacer Adapter T81P-6135-A or equivalent.



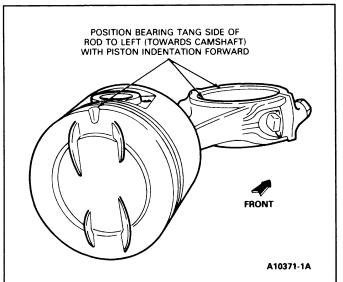
#### **Assembly**

The piston, connecting rod and related parts are shown in the illustration. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod. Refer to Section 03-00, Engine, Gasoline—General Service.

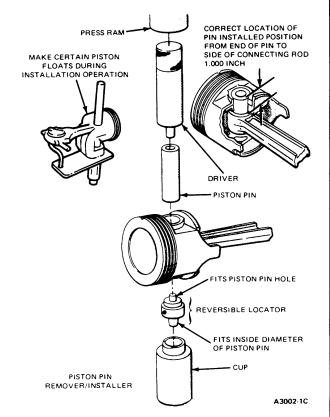
The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.



Apply a light coat of engine oil to all parts.
 Assemble the piston to the connecting rod with the bearing tang side of the connecting rod and the indentation notch in the piston positioned as shown.



 Start the piston pin in the piston and connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the pin is centered in the connecting rod. To install piston pin use either Piston Pin Remover / Replacer T68P-6135-A or equivalent.



 Check the end gap of all piston rings. Refer to Section 03-00, Engine, Gasoline—General Service. It must be within specifications listed at end of this section. Follow the instructions contained on the piston ring package and install the piston rings.

- 4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. Refer to Section 03-00, Engine, Gasoline—General Service. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have steps, the piston should be replaced.
- 5. Ensure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

# Cylinder Block

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs. Refer to Section 03-00, Engine, Gasoline—General Service.

# Disassembly

- Mount the old engine in a work stand and completely disassemble it, removing the cylinder head and manifolds as an assembly. Follow Engine Components Removal and Installation procedures.
- 2. Remember to ridge-ream the cylinder bores before removing the piston assemblies.
- 3. Remove the cylinder head locating dowels.

#### Assembly

- Clean the gasket and seal surfaces of all serviceable parts and assemblies.
- Position the new cylinder block in the work stand and transfer all serviceable parts removed from the old cylinder block following Engine Components Removal and Installation procedures.

- Install the cylinder head locating dowels and block drain plugs.
- 4. Check all assembly clearances and correct as necessary.

# **Cylinder Assembly**

#### Disassembly

- Mount the old engine in a work stand.
- Remove the cylinder head and manifolds as an assembly.
- Remove all serviceable parts not furnished with the new cylinder assembly, including the cylinder block drain plugs and cylinder head locating dowels.

#### **Assembly**

- Clean the gasket and seal surfaces of all serviceable parts and assemblies.
- Position the new cylinder assembly in a work stand and transfer all serviceable parts removed from the old cylinder assembly following Engine Components Removal and Installation procedures.
- Install the cylinder head locating dowels and block drain plugs. Install the cylinder head and manifolds as an assembly.
- Check all assembly clearances and correct as necessary.

#### CLEANING AND INSPECTION

Refer to Cleaning and Inspection Procedures in Section 03-00, Engine, Gasoline—General Service.

# **SPECIFICATIONS**

#### **GENERAL SPECIFICATIONS**

| Engine             | Bore and Stroke | Firing Order | Oil Pressure<br>Hot @ 2000 RPM<br>kPa (PSI) | Engine Type<br>and Number of<br>Cylinders |
|--------------------|-----------------|--------------|---|---|
| 4.9L (300 CID) I-6 | 4.00 x 3.98     | 153624       | 275 (40-60)                                 | O.H.V. I-6                                |

# **CYLINDER HEAD**

| Engine     | Combustion<br>Chamber<br>Volume | Valve Guide<br>Bore Diameter |                 | Valve Seat<br>Width① |                            | Valve Seat<br>Runout TIR<br>Maximum | Valve<br>Arrangement<br>Front to Rear | Gasket<br>Surface<br>Flatness(2)  | Rocker Arm<br>Falcrum Thread<br>Diameter Std.(1) |
|------------|---------------------------------|------------------------------|-----------------|----------------------|----------------------------|-------------------------------------|---------------------------------------|-----------------------------------|--|
|            | C.C.③                           | Intake                       | Exhaust         | intake               | Exhaust                    | Maximum                             | Hone to near                          | I latiless Z                      | Diameter Std.                                    |
| 4.9L (300) | 65.4-<br>68.4                   | .3433-<br>.3443              | .3433-<br>.3443 | .060-<br>.080        | .070-<br>.0 <del>9</del> 0 | .002                                | E-I-E-I-E-I-<br>E-I-E-I-E-I           | .006 in any 6 in.<br>.007 overall | 5/16-18  |

①Valve seat angle — 45°.

#### VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

| Engine             | Rocker Arm      | Push Rod<br>Runout<br>TIR Maximum |                      | Valve Tappet or       | Collapsed Tappet Gap (Clearance)   |           |         |
|--------------------|-----------------|-----------------------------------|----------------------|-----------------------|------------------------------------|-----------|---------|
|                    | Lift Ratio to 1 |                                   | Standard<br>Diameter | Clearance<br>to Bore① | Hydraulic Lifter<br>Leakdown Rate2 | Allowable | Desired |
| 4.9L (300 CID) 1-6 | 1.61            | .015                              | .87408745            | .00070027             | 10 to 50 seconds for 1/16 travel   | .100200   | .125175 |

 $<sup>\</sup>label{eq:service limit} \textbf{ } \textbf{ } \textbf{.005}.$ 

#### **VALVE SPRINGS**

| Engine             | Valve Spring Compression Pressure Lbs. @ Specified Height |                                  | Valve Spring<br>Free Length<br>(Approximate) |         | Valve S<br>Assen<br>Heigt | Valve Spring Out Of |             |
|--------------------|---|----------------------------------|--|---------|---------------------------|---------------------|-------------|
|                    | Intake(1)   | Exhaust                          | Intake                                       | Exhaust | Intake                    | Exhaust             | Square      |
| 4.9L (300 CID) 1-6 | 66-74 @ 1.640<br>166-184 @ 1.240                          | 66-74 @ 1.470<br>166-184 @ 1.070 | 1.96   | 1.78    | 1.61-1.67                 | 1.44-1.50           | 5/64 (.078) |

Service limit — 10% loss of pressure.
 Pad to retainer.

#### **VALVES**

| Engine             | Valve S<br>Guide Cle | · · · · · · · · · · · | Valve Head  | Diameter 2  | Valve Face Runout<br>TIR Maximum |  |
|--------------------|----------------------|-----------------------|-------------|-------------|----------------------------------|--|
|                    | Intake               | Exhaust               | Intake      | Exhaust     | iin maximum                      |  |
| 4.9L (300 CID) I-6 | .00100027            | .00100027             | 1.769-1.793 | 1.551-1.569 | .0020                            |  |

Service clearance — .0055 Maximum.
 Valve face angle — 44°.

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②Gasket surface finish — RMS 60-150.

<sup>(</sup>PSI) of the lowest cylinder must be at least 75% of the highest to be within specification.

<sup>2)</sup>Time required for plunger to leakdown .0625 under load of 50 lbs. using leakdown fluid in tappet.

#### **VALVES (Continued)**

|                    | Valve Stem Diameter |           |           |           |               |           |  |  |  |
|--------------------|---------------------|-----------|-----------|-----------|---------------|-----------|--|--|--|
| Engine             | Stan                | dard      | .015 O    | versize   | .030 Oversize |           |  |  |  |
|                    | Intake              | Exhaust   | intake    | Exhaust   | Intake        | Exhaust   |  |  |  |
| 4.9L (300 CID) I-6 | .34163423           | .34163423 | .35663573 | .35663573 | .37163723     | .37163723 |  |  |  |

#### CAMSHAFT

| Engine             | Lobe     | Lift①    | Camshaft | Camshaft Journal To |                     |
|--------------------|----------|----------|----------|---------------------|---------------------|
|                    | Intake   | Exhaust  | End Play | Service Limit       | Bearing Clearance 2 |
| 4.9L (300 CID) I-6 | .249247③ | .249247③ | .001007  | .009                | .001003             |

Maximum allowable lift loss — .005.

#### CAMSHAFT DRIVE

| Engine             | Camshaft Journal Diameter — Standard ① |                 |                 | Camshaft Bearing Inside Diameter |                 |                 |                 | Camshaft Front<br>Bearing | Assembled Gear Face<br>Runout③ |            |          |
|--------------------|--|-----------------|-----------------|----------------------------------|-----------------|-----------------|-----------------|---------------------------|--------------------------------|------------|----------|
|                    | No. 1                                  | No. 2           | No. 3           | No. 4                            | No. 1           | No. 2           | No. 3           | No. 4                     | Location 2                     | Crankshaft | Camshaft |
| 4.9L (300 CID) I-6 | 2.017-<br>2.018                        | 2.017-<br>2.018 | 2.017-<br>2.018 | 2.017-<br>2.018                  | 2.019-<br>2.020 | 2.019-<br>2.020 | 2.019-<br>2.020 | 2.019-<br>2.020           | .020035                        | .005       | .005     |

①Camshaft journal runout — .008 TIR maximum.

#### CYLINDER BLOCK

| Engine             | Cylinder Bore<br>Diameter 1 | Main Bearing Bore<br>Diameter 2 | Distributor Shaft<br>Bearing Bore<br>Diameter | Head Gasket<br>Surface Flatness   | Head Gasket<br>Surface Finish | Tappet Bore<br>Diameter |
|--------------------|-----------------------------|---------------------------------|---|-----------------------------------|-------------------------------|-------------------------|
| 4.9L (300 CID) I-6 | 4.0000-4.0048               | 2.5902-2.5910                   | .51555165                                     | .003 in any 6 in.<br>.006 overall | RMS<br>60-150                 | .87528767               |

①Maximum out-of-round .0015, Service limit — .005, Maximum taper service limit — .010, Cylinder bore surface finish RMS 18-38, Bore taper service limit —

#### CRANKSHAFT AND FLYWHEEL

| Engine             | Main Bearing<br>Journal<br>Diameter 1 | Main Bearing<br>Journal Runout<br>TIR Maximum② | Main Bearing<br>Thrust Face<br>Runout<br>TIR Maximum |       | Thrust Bearing<br>Journal Length |    |                       |
|--------------------|---------------------------------------|--|--|-------|----------------------------------|----|-----------------------|
| 4.9L (300 CID) I-6 | 2.3982-2.3990                         | .002   | .001   | .0005 | 1.1990-1.2010                    | 12 | 35 Front — 25<br>Rear |

①Maximum out-of-round — .0006.

## **CRANKSHAFT AND FLYWHEEL (Continued)**

| Engine             | Engine Connecting Rod |                     | Connecting Rod<br>Journal Taper |                     | Flywheel<br>Lateral R | Flywheel Clutch |                 |
|--------------------|-----------------------|---------------------|---------------------------------|---------------------|-----------------------|-----------------|-----------------|
| g                  | Journal<br>Diameter 1 | Per Inch<br>Maximum | Crankshaft Free<br>End Play 2   | Runout<br>Assembled | Std. Trans.           | Auto. Trans.    | Face<br>Run-out |
| 4.9L (300 CID) I-6 | 2.1228-2.1236         | .0006               | .004008                         | .010                | .040                  | .060            | 0.010           |

①Maximum out-of-round — .0006. ②Service limit — .012.

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Service clearance — .006.

③F-150 4 x 2 w/2.47:1 or 2.75:1 axle ratio and manual transmission (49S).

<sup>2)</sup> Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

<sup>3</sup> Gear backlash -- .004-.010.

<sup>(2)</sup> Crankshaft to rear face of block runout. TIR maximum .005.

Service limit — .005.

#### **CRANKSHAFT BEARINGS**

|                    | Connecting R | od Bearing to Crank<br>Selective Fit | Main Bearing to Crankshaft Clearance<br>Selective Fit |           |           |                                   |
|--------------------|--------------|--------------------------------------|---|-----------|-----------|-----------------------------------|
| Engine             | Desired      | Allowable                            | Bearing Wall<br>Thickness Std.1                       | Desired   | Allowable | Bearing Wall<br>Thickness Std.(1) |
| 4.9L (300 CID) I-6 | .00080015    | .00070024                            | .07520757   | .00080015 | .00100028 | .09510956                         |

<sup>1)</sup> For .002 undersize add .001 to standard wall thickness.

#### **CONNECTING ROD**

|                    | Piston Pin Bore or | Rod Bearing Bore | Rod Length       | Corinecting R<br>Maximum Tot | Rod to Crankshaft<br>Assembled Side |            |
|--------------------|--------------------|------------------|------------------|------------------------------|-------------------------------------|------------|
| Engine             | Bushing I.D.       | I.D.①            | Center to Center | Twist②                       | Bend2                               | Clearance3 |
| 4.9L (300 CID) I-6 | .97349742          | 2.2750-2.2758    | 6.2082-6.2112    | .024                         | .012                                | .006013    |

① Connecting rod bearing bore maximum out-of-round — .006.

#### PISTON

|                        | Diameter (1)  |               | Piston to ②<br>Bore Clearance | Piston<br>Pin Bore | R         | ing Groove Wid<br>Compression | th      |         |
|------------------------|---------------|---------------|-------------------------------|--------------------|-----------|-------------------------------|---------|---------|
| Engine                 | Coded Red     | Coded Blue    | .003 Oversize                 | Selective Fit      | Diameter  | Тор                           | Bottom  | Oil     |
| 4.9L (300 CID)<br>I-6② | 3.9982-3.9988 | 3.9994-4.0000 | 4.0008-4.0014                 | .00100018          | .97549757 | .080081                       | .080081 | .188189 |

<sup>1)</sup> Measured at the piston pin bore centerline at 90° to the pin.

#### PISTON PIN

|                    |             | Diameter  |               |               | To Piston Pin   | To Connecting Rod |
|--------------------|-------------|-----------|---------------|---------------|-----------------|-------------------|
| Engine             | Length      | Standard  | .001 Oversize | .002 Oversize | Bore Clearance① | Bushing Clearance |
| 4.9L (300 CID) I-6 | 3.150-3.170 | .97490754 | .97609763     | .97709773     | .00020004②      | Interference Fit  |

<sup>1)</sup> Selective Fit.

#### **PISTON RINGS**

|                    | Ring Width ( | Compression | Side Cle  | Clearance Compression(1) |      | Ring Gap Compression |         | sion    |
|--------------------|--------------|-------------|-----------|--------------------------|------|----------------------|---------|---------|
| Engine             | Тор          | Bottom      | Тор       | Bottom                   | Oil  | Тор                  | Bottom  | Oll②    |
| 4.9L (300 CID) I-6 | .07740781    | .07700780   | .00190036 | .002004                  | Snug | .010020              | .010020 | .015055 |

① Service limit — .002 maximum increase in clearance.

#### OIL PUMP AND OIL CAPACITY

|                    | Relief Valve     |           |                            |                |                          | Engine | e Oil Cap | acity  |                          |
|--------------------|------------------|-----------|----------------------------|----------------|--------------------------|--------|-----------|--------|--------------------------|
|                    | Spring Pressure  |           | Relief Valve to<br>Housing | Rotor Assembly | Outer Race to<br>Housing | U.S.   | imperial  |        | inner②<br>to Outer Rotor |
| Engine             | Length           | Clearance | Clearance                  | End Clearance  | Clearance                | Quarts | Quarts    | Liters | Tip Clearance            |
| 4.9L (300 CID) I-6 | 20.6-22.6 @ 2.49 | .00150030 | .00150030                  | .004 Maximum   | .001013                  | 5      | 4-2       | 4-7    | .012 Maximum             |

<sup>1)</sup> Add 1 U.S. Quart (or equivalent in Imperial Quarts or Liters) when replacing filter.

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## TORQUE LIMITS — 4.9L (300 CID) I-6 ENGINE

NOTE: All values are in N+m (ft-lbs) unless otherwise noted. Oil threads with engine oil unless the threads require oil or water-resistant sealer. The standard torque limits listed below are applicable for all functions not listed in the special torque chart.

| 1/4-20     | 5/16-18       | 5/16-24       | 2/8-16        | 3/8-24        | 7/16-14       | 7/16-20       | 1/2-13         | 9/16-18          |
|------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|------------------|
| 8-12 (6-9) | 17-24 (12-18) | 19-27 (14-20) | 30-43 (22-32) | 37-51 (27-38) | 55-75 (40-55) | 55-81 (40-60) | 75-109 (55-80) | 116-162 (85-120) |

CA4969-2C

② Pin bushing and crankshaft bore must be parallel and in ame vertical plan within specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

<sup>3</sup> Service limit - .018.

Rebuild specification only.

② Under 8500 Lbs. GVW-.0003-.0005.

<sup>2</sup> Steel rail.

<sup>2)</sup> With feeler gauge inserted ½ inch minimum and rotor removed from pump housing.

# PIPE THREADS

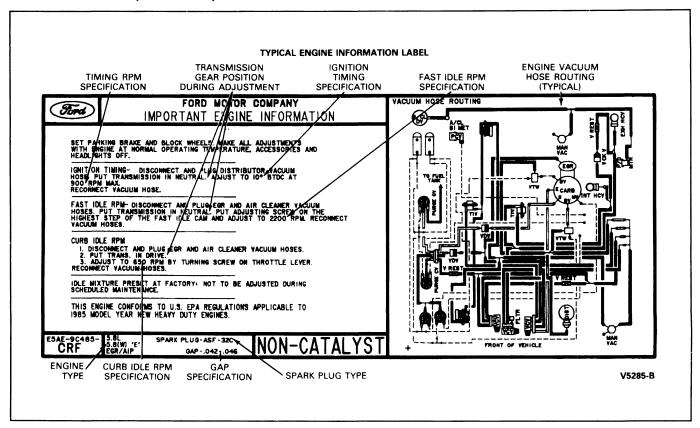
| 1/8-27     | 1/4-18        | 3/8-18        | 1/2-14        |
|------------|---------------|---------------|---------------|
| 7-11 (5-8) | 17-24 (12-18) | 30-44 (22-33) | 34-47 (25-35) |

#### **TORQUE SPECIFICATIONS**

| Mana   | Tor                          | que             | Item  | To    | rque                |
|--|------------------------------|-----------------|---|-------|---------------------|
| Item   | N-m                          | ft-lbs          | nem   | N-m   | ft-lbs              |
| Connecting Rod Nut   | 55-61                        | 40-45           | Water Outlet Housing                        | 17-24 | 12-18               |
| Cylinder Front Cover   | 17-24                        | 12-18           | Water Pump to Block/Front Cover             | 17-24 | 12-18               |
| Cylinder Head Bolts  | ①                            | ①               | Alternator Bracket to Cylinder Block — Bolt | 41-61 | 30-45               |
| Damper to Crankshaft   | 177-203                      | 130-150         | Alternator Adjusting Arm to Cylinder        |       |                     |
| EGR Valve to Intake Manifold   | 17-24                        | 12-18           | Block Bolt                                  | 26-36 | 19-27               |
| Flywheel to Crankshaft   | 102-115                      | 75-85           | Alternator Adjusting Arm to Alternator Bolt | 33-54 | 24-40               |
| Main Bearing Cap Bolts   | 82-94                        | 60-70           | Thermactor Pump Pivot Bolt                  | 41-48 | 30-35               |
| Manifold to Cylinder Head — Intake2  | 30-43                        | 22-32           | Thermactor Pump Adjusting Arm to Pump       | 30-43 | 22-32               |
| Manifold to Cylinder Head — Exhaust2   | 30-43                        | 22-32           | Thermactor Pump Pulley to Pump Hub          | 17-24 | (150-220<br>in-lbs) |
| Oil Filter Insert to Cylinder Block/Adaptor  | 20-48                        | 15-35           | Thermactor Pump Bracket to Cylinder Block   | 30-43 | 22-32               |
| Oil Filter Adaptor to Cylinder Block   | 55-67                        | 40-50           | Fuel Filter to Carburetor/Pump              | 10-11 | (80-100 in-lbs      |
| Oil Filter to Adaptor or Cylinder Block  | 1/2 turn after               |                 | Throttle Body Attaching Nuts                | 19-27 | 14-20               |
|  | contacts seali — oiled gaske |                 | Camshaft Thrust Plate to Cylinder Block     | 16-24 | 12-18               |
| Oil Inlet Tube to Pump   | 14-20                        | 10-15           | Fuel Pump to Cylinder Block/Front Cover     | 17-24 | 12-18               |
| Oil Pan Drain Plug   | 21-33                        | 15-25           | Carburetor Mounting Stud                    | 7-13  | 5-10                |
| Oil Pan to Cylinder Block    Oil Pan to Cylinder Block   Oil Pan to Cylinder Block  Oil Pan to Cylinder Block  Oil Pan to Cylinder Block | 20-24                        | 15-18           | Distributor Clampdown                       | 24-33 | 17-25               |
| Oil Pump to Cylinder Block   | 14-20                        | 10-12           | Intake Manifold Vacuum Fittings             | 8-13  | 6-10                |
| Oil Inlet Tube to Main Bearing Cap   | 30-43                        | 22-32           | Timing Pointer to Front Cover               | 17-24 | 12-18               |
| Pulley to Damper Bolt  | 48-67                        | 35-50           | Thermactor Air Manifold to Cylinder Head    |       |                     |
| Rocker Arm Bolt  | 24-31                        | 17-23           | (Nut and Ferrule Assy.)                     | 19-22 | 14-16               |
| Spark Plug to Cylinder Head  | 14-20                        | 10-15           | Thermactor Air Check Valve to Thermactor    | 00.00 | 10.10               |
| Valve Rocker Arm Cover②  | 7.9-11.9                     | (70-105 in-lbs) | Air Manifold                                | 22-26 | 16-19               |
| Valve Push Rod — Cover to Cylinder Block   | 2.8-3.9                      | (25-35 in-lbs)  | Pressure Plate and Cover Assy. to Flywheel  | 16-25 | 12-18               |

Progressively increase the tightness in three steps using this sequence:
 1st step — tighten all bolts to 67-75 N+m (50-55 ft-lb)
 2nd step — tighten all bolts to 82-88 N+m (60-65 ft-lb)
 3rd step — tighten all bolts to 94-115 N+m (70-85 ft-lb)
 3rd step — tighten all bolts to 94-115 N+m (70-85 ft-lb)

CA4970-G



## **SPECIAL SERVICE TOOLS**

#### **SPECIAL SERVICE TOOLS**

| Tool Number   | Description                          | Tool Number   | Description                                  |
|---------------|--------------------------------------|---------------|--|
| T50T-100-A    | Impact Slide Hammer                  | T82T-6256-A   | Camshaft Gear Puller                         |
| T59L-100-B    | Impact Slide Hammer                  | TOOL-6331-E   | Upper Main Bearing Insert Remover & Replacer |
| T58L-101-B    | Puller                               | T74P-6375-A   | Flywheel Holding Tool                        |
| D78P-4201-B   | Dial Indicator Mag. Base             | TOOL-6500-E   | Hydraulic Tappet Leakdown Tester             |
| TOOL-4201-C   | Dial Indicator With Bracketry        | T70P-6513-A   | Tappet Bleed Down Wrench                     |
| T70P-6000     | Engine Lifting Bracket               | TOOL-6513-ABA | Valve Holdup Air Adapter                     |
| T64L-6011-EA  | Cylinder Ridge Reamer                | TOOL-6513-DD  | Valve/Clutch Spring Tester                   |
| T73L-6011-A   | Cylinder Hone Set                    | T79T-6527-B   | Rocker Arm Stud Replacer                     |
| T61P-6019-B   | Front Cover Aligner                  | T70P-6049-A   | Valve Spring Compressor                      |
| T68P-6135-A   | Piston Pin Remover/Replacer          | TOOL-6565-AB  | Cup Shaped Adapter                           |
| T81P-6135-A   | Piston Pin Remover/Replacer Adapters | T73L-6600-A   | Pressure Gauge                               |
| T65L-6250-A   | Camshaft Bearing Set                 | D79P-6666-A   | Spark Plug Boot Puller                       |
| T65L-6306-A   | Camshaft Gear Replacing Adapter      | T74P-6666-A   | Spark Plug Wire Remover                      |
| T52L-6306-AEE | Crankshaft Damper Replacer           | T89P-6701-AH  | Rear Oil Seal Replacer                       |
| D81L-6002-C   | Piston Ring Compressor               | D79L-6731-A   | Oil Filter Wrench                            |
| T70P-6B070-B  | Front Cover Seal Remover             | D79L-6731-B   | Oil Filter Wrench                            |
| T70P-6B070-A  | Front Cover Seal Replacer            | T74P-7137-A   | Pilot Bearing Replacer                       |
| T58P-6316-D   | Crankshaft Damper Remover            | T83T-6701-B   | Rear Oil Seal Pilot Tool                     |

CA6539-2G

# **SPECIAL SERVICE TOOLS (Continued)**

| OTUNDA TOOLS |                   |  |
|--------------|-------------------|--|
| Model No.    | Description       |  |
| 014-00036    | Engine Sling      |  |
| 014-00133    | Floor Crane       |  |
| 066-00017    | Transmission Jack |  |

# SECTION 03-01B Engines—5.0L EFI (302 CID) V-8 and 5.8L EFI (351 CID) W-V-8

| SUBJECT                               | PAGE      | SUBJECT                              | PAGE      |
|---------------------------------------|-----------|--------------------------------------|-----------|
| ADJUSTMENTS                           |           | IN-VEHICLE SERVICE (Cont'd.)         |           |
| Valve Clearance                       | 03-01B-4  | Engine Components                    | 03-01B-7  |
| DESCRIPTION                           |           | Engine Front Supports                |           |
| Crankcase Ventilation System          | 03-01B-4  | Engine Rear Supports                 |           |
| Engine                                |           | Exhaust Manifolds                    | 03-01B-27 |
| Exhaust Emission Control System       |           | Flywheel                             |           |
| DIAGNOSIS AND TESTING                 |           | Front Oil Seal                       |           |
| DISASSEMBLY AND ASSEMBLY              |           | Intake Manifold                      | 03-01B-23 |
| Cylinder Block Assembly—(6009)        | 03-01B-57 | Main Bearing                         |           |
| Cylinder Block — (6010)               |           | Oil Filter                           |           |
| Cylinder Heads                        |           | Oil Pan                              |           |
| Engine                                |           | Oil Pump                             |           |
| Oil Pump                              | 03-01B-55 | Pistons and Connecting Rods          | 03-01B-38 |
| Pistons and Connecting Rods           |           | Tappet                               | 03-01B-25 |
| Tappet                                |           | Valve Rocker Arm Cover and Rocker    |           |
| IN-VEHICLE SERVICE                    |           | Arm                                  | 03-01B-21 |
| Camshaft                              | 03-01B-33 | Valve Spring, Retainer and Stem Seal |           |
| Camshaft Rear Bearing Bore Plug       | 03-01B-35 | Water Pump                           |           |
| Clutch Pilot Bearing                  |           | REMOVAL AND INSTALLATION             |           |
| Connecting Rod Bearings               | 03-01B-38 | Camshaft Bearings                    | 03-01B-46 |
| Crankcase Ventilation System          | 03-01B-15 | Crankshaft                           | 03-01B-44 |
| Crankshaft Rear Oil Seal              | 03-01B-36 | Engine Assembly                      | 03-01B-40 |
| Cylinder Front Cover and Timing Chain | 03-01B-28 | SPECIAL SERVICE TOOLS                | 03-01B-64 |
| Cylinder Heads                        |           | SPECIFICATIONS                       | 03-01B-58 |
| Electronic Fuel Injection             | 03-01B-16 | VEHICLE APPLICATION                  | 03-01B-1  |

#### **VEHICLE APPLICATION**

E-150—E-350, F-150—F-350 and Bronco Vehicles Equipped with 5.0L or 5.8L EFI Engines

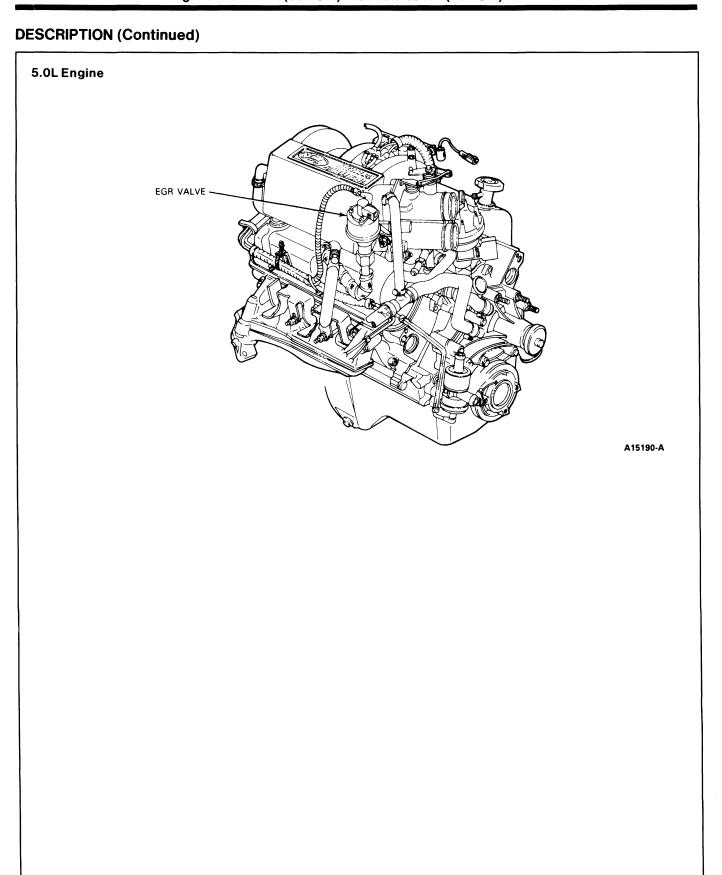
# **DESCRIPTION**

WARNING: DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

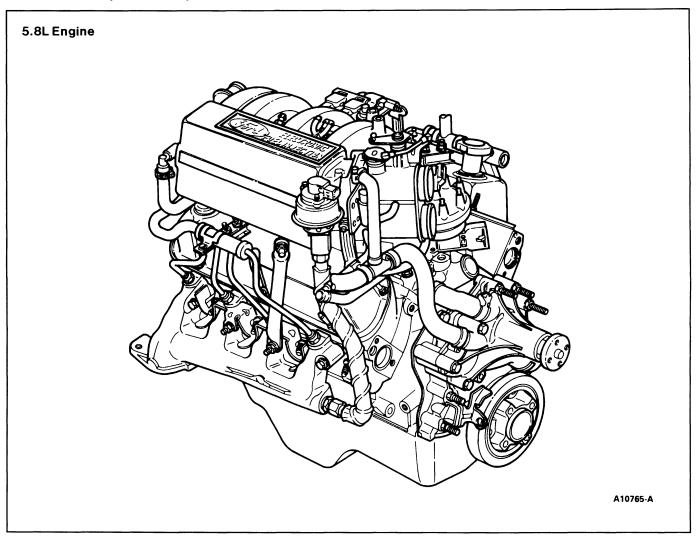
#### **Engine**

The 5.0L (302 CID) EFI V-8 and 5.8L (351 CID) EFI W-V-8 engines have the same basic design. The cylinder block for these engines is of special high-grade cast iron, thin-wall construction. The crankshaft has five main bearings and is precision-cast nodular iron. Pistons are aluminum alloy, tin plated. Valve rocker arms are individually bolt mounted. The valve tappets are hydraulic.

The 5.0L (302 CID) EFI V-8 is used as an option on some F-150—F-250 and Bronco models also E-150, and E-250. An aluminum intake manifold is used on 5.0L EFI and 5.8L (351 CID) EFI W-V-8 engines. Refer to specifications.

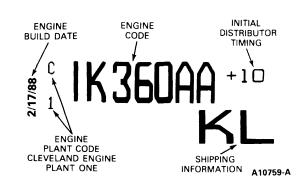


# **DESCRIPTION (Continued)**



## **Engine Code Information Label**

The engine code information label, located on the side of the RH rocker arm cover, contains the engine build date, engine plant code, the engine code, and the initial distributor timing.



#### **Emission Calibration Label**

The emission calibration number label is located on the LH side door or LH door post pillar. It identifies the engine calibration number, the engine code number and revision level.

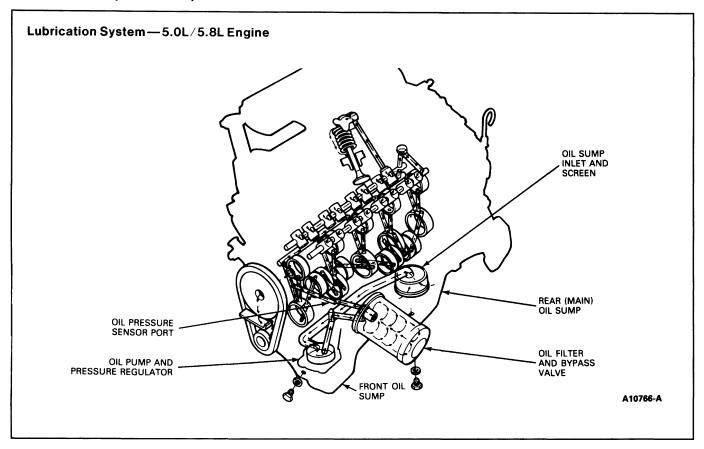
These numbers are used to determine if parts are unique to specific engines.

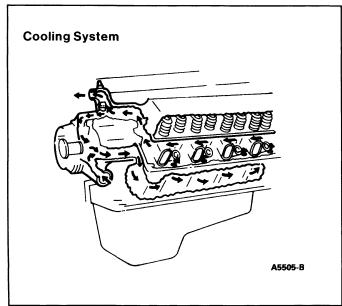
NOTE: It is imperative that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.



A10693-1A

# **DESCRIPTION (Continued)**





#### **Exhaust Emission Control System**

Operation and required maintenance of the exhaust emission control devices used on these engines are covered in the Emissions Diagnosis\* manual.

# **Crankcase Ventilation System**

These engines are equipped with a positive closed-type crankcase ventilation system directing the crankcase vapors to the intake manifold for combustion.

## **DIAGNOSIS AND TESTING**

Refer to Diagnosis and Testing in Section 03-00, Engine—Gasoline—General Service.

# **ADJUSTMENTS**

#### **Valve Clearance**

The valve arrangement of the LH bank is E-I-E-I-E-I and on the RH bank is I-E-I-E-I-E.

A 1.52mm (0.060 inch) shorter push rod or a 1.52mm (0.060 inch) longer push rod is available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the Specifications listed at the end of the section for the appropriate color code.

<sup>\*</sup>Can be purchased as a separate item.

# **ADJUSTMENTS (Continued)**

Valve stem-to-valve rocker arm clearance should be within specifications with the hydraulic tappet completely collapsed. Repeated valve reconditioning operations (valve and / or valve seat refacing) will decrease the clearance to the point that if it is not compensated for, the hydraulic valve tappet will cease to function and the valve will be held open.

The positive stop rocker arm bolts eliminates the necessity to adjust the valve clearance. However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and tightened properly.

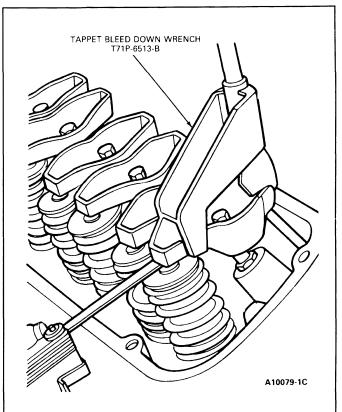
To determine whether a shorter or a longer push rod is necessary, make the following check.

#### 5.0L (302 CID) EFI V-8 Engine

- Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay.
- Install an auxiliary starter switch between the battery and S terminal of the starter relay. Crank the engine with the ignition switch in OFF position until the No. 1 piston is on TDC after the compression stroke.
- With the crankshaft in the positions designated in steps 3, 4 and 5, position the tappet compressor using Tappet Bleed Down Wrench Tool T7 1P-6513-B or equivalent on the rocker arm.

Slowly apply pressure to bleed down the tappet until the plunger is completely bottomed. Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.



4. With the No. 1 piston on TDC at the end of the compression stroke, POSITION 1, check the following valves:

No. 1 Intake No. 1 Exhaust

No. 7 Intake No. 5 Exhaust

No. 8 Intake No. 4 Exhaust

Rotate the crankshaft to POSITION 2 and check the following valves.

No. 5 Intake No. 2 Exhaust

No. 4 Intake No. 6 Exhaust

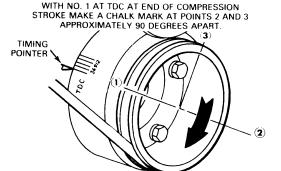
Rotate the crankshaft to POSITION 3 and check the following valves.

No. 2 Intake No. 7 Exhaust

No. 3 Intake No. 3 Exhaust

# **ADJUSTMENTS (Continued)**





POSITION 1 — NO. 1 AT TDC AT END OF COMPRESSION STROKE.

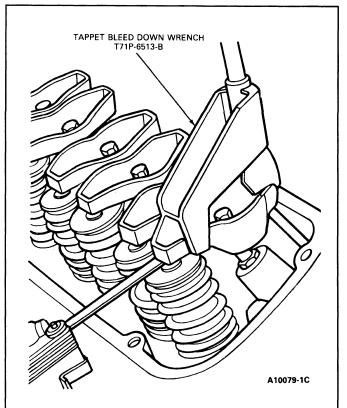
POSITION 2 — ROTATE THE CRANKSHAFT 180 DEGREES (1/2 REVOLUTION) CLOCKWISE FROM POSITION 1.

POSITION 3 — ROTATE THE CRANKSHAFT 270 DEGREES (3/4 REVOLUTION) CLOCKWISE FROM

A3234-H

## 5.8L (351 CID) EFI W-V-8 Engine

- Disconnect the red and blue leads (S terminal) at the starter relay.
- Install an auxiliary starter switch between the battery and S terminals of the starter relay. Crank the engine with the ignition switch in OFF position until the No. 1 piston is on TDC on the compression stroke.
- 3. With the crankshaft in the positions designated in steps 4, 5 and 6, position the tappet compressor tool on the rocker arm. Slowly apply pressure to bleed down the tappet until the plunger is completely bottomed. Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.



 With the No. 1 piston on TDC at the end of the compression stroke, POSITION 1 check the following valves:

No. 1 Intake No. 1 Exhaust

No. 4 Intake No. 3 Exhaust

No. 8 Intake No. 7 Exhaust

After these valves have been checked, rotate the crankshaft to POSITION 2 and check the following valves:

No. 3 Intake No. 2 Exhaust

No. 7 Intake No. 6 Exhaust

 After these valves have been checked, rotate the crankshaft to POSITION 3 and check the following valves:

No. 2 Intake No. 4 Exhaust

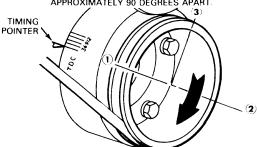
No. 5 Intake No. 5 Exhaust

No. 6 Intake No. 8 Exhaust

# **ADJUSTMENTS (Continued)**

If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.

WITH NO. 1 AT TDC AT END OF COMPRESSION STROKE MAKE A CHALK MARK AT POINTS 2 AND 3 APPROXIMATELY 90 DEGREES APART.



POSITION 1 — NO. 1 AT TDC AT END OF COMPRESSION STROKE.

POSITION 2 — ROTATE THE CRANKSHAFT 180 DEGREES (1/2 REVOLUTION) CLOCKWISE FROM POSITION 1.

POSITION 3 — ROTATE THE CRANKSHAFT 270 DEGREES (3/4 REVOLUTION) CLOCKWISE FROM POSITION 2.

A3234-H

# **IN-VEHICLE SERVICE**

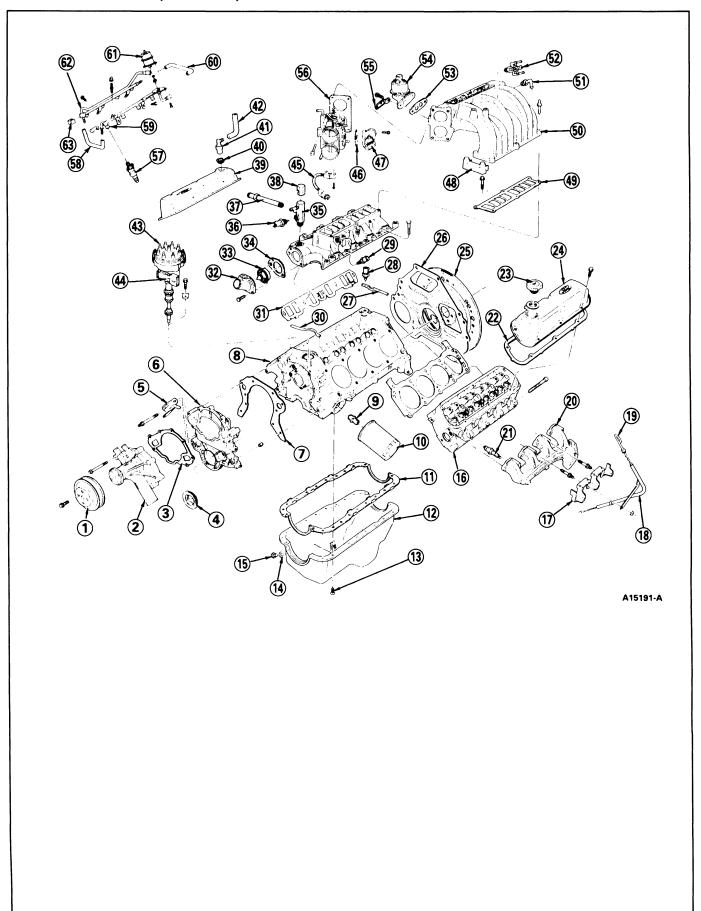
WARNING: TO AVOID THE POSSIBILITY OF PERSONAL INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

The following procedures can be performed with the engine in the vehicle. When installing nuts or bolts that must be tightened (refer to torque specifications), oil the threads with lightweight engine oil. Do not oil threads that require oil-resistant or water-resistant sealer.

Refer to Section 03-00, Engine—Gasoline—General Service for Cleaning, Inspection and Test procedures.

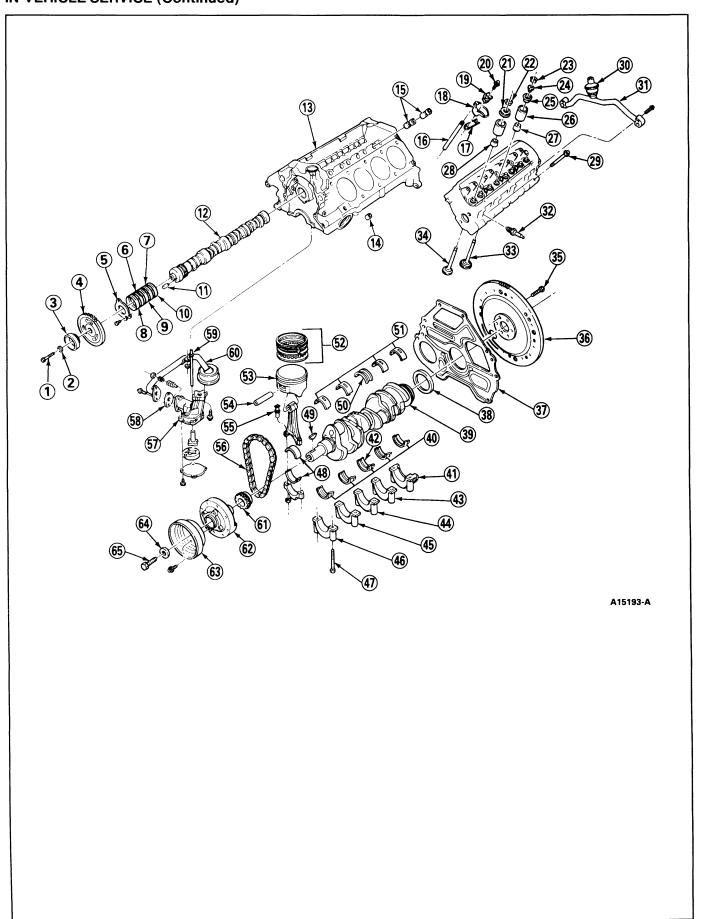
# **Engine Components**

Engine components shown are typical and provide a reference for procedures. The numbers shown are basic part numbers corresponding with the Ford Master Parts Catalog.



| REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                               | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                             |
|-------------|-------------------|---|-------------|-------------------|---|
| 1           | 8509              | Pulley                                    | 32          | 8592              | Connection — Water Outlet               |
| 2           | 8501              | Water Pump                                | 33          | 8575              | Thermostat — Water                      |
| 3           | 8507              | Gasket — Water Pump Housing               | 34          | 8255              | Gasket — Water Outlet Conn.             |
| 4           | 6700              | Seal — Cylinder Front Cover               | 35          | 18A568            | Connector — Sensor                      |
| 5           | 6023              | Pointer — Timing                          | 36          | 12A648            | Sensor Assy. — EEC Coolant Temp.        |
| 6           | 6059              | Cover Assy. — Cylinder Front              | 37          | 18K396            | Tube — Heater Hot Water                 |
| 7           | 6020              | Gasket — Cylinder Front Cover             | 38          | 8A565             | Car — Protective                        |
| 8           | 6010              | Block Assy.                               | 39          | 6582              | Cover Assy. — Valve Rocker Arm (RH)     |
| 9           | 6890              | Insert — Oil Filter Adaptor               | 40          | 6K780             | Grommet — PCV Valve                     |
| 10          | 6714              | Oil Filter                                | 41          | 6B890             | Valve Assy. — PCV                       |
| 11          | 6710              | Gasket — Oil Pan                          | 42          | 6A664             | Hose — Crankcase Ventilation            |
| 12          | 6675              | Pan Assy. — Oil                           | 43          | 12106             | Cap — Distributor                       |
| 13          | 387549            | Bolt                                      | 44          | 12A332            | Ignition Module — TF!                   |
| 14          | 6734              | Seal — Oil Drain Plug                     | 45          | 9B989             | Potentiometer Assy. — Throttle          |
| 15          | 6730              | Drain Plug — Oil                          | 46          | 9F670             | Gasket — Air-By-Pass                    |
| 16          | 6049              | Head — Cylinder                           | 47          | 9F715             | Valve Assy. — Air By-Pass               |
| 17          | 12A087            | Heat Shield                               | 48          | 9F460             | Shield — Intake Manifold                |
| 18          | 6754              | Tube Assy. — Oil Level Indicator          | 49          | 9H486             | Gasket — Intake Manifold, Upper         |
| 19          | 6750              | Indicator — Oil Level                     | 50          | 9425              | Manifold — Intake                       |
| 20          | 9428              | Manifold — Exhaust (RH)                   | 51          | 9A474             | Fitting — Intake Manifold Vacuum Outlet |
|             | 9431              | Manifold — Exhaust (LH)                   | 52          | 9D446             | Fitting — Intake Manifold Vacuum Tree   |
| 21          | 12405             | Spark Plug                                | 53          | 9D476             | Gasket — EGR Valve                      |
| 22          | 6584              | Gasket — Valve Rocker Arm Cover           | 54          | 9F483             | Valve Assy. — EGR Pressure External     |
| 23          | 6766              | Cap Assy. — Oil Filler                    | 55          | 14A163            | Retainer — Wiring Harness               |
| 24          | 6A505             | Cover Assy. — Valve Rocker Arm (LH)       | 56          | 9E936             | Gasket — Throttle Body                  |
| 25          | 6375              | Flywheel                                  | 57          | 9F593             | Injector Assy. — Fuel                   |
| 26          | 6A373             | Plate Assy. — Engine Rear                 | 58          | 9F793             | Connecting Hose — Fuel Rail Front       |
| 27          | 9A424             | Gasket — Manifold                         | 59          | 9D280             | Manifold — Fuel Injection Supply (LH)   |
| 28          | 12A699            | Sensor Assy. — Eng. Spark Knock Intensity | 60          | 9F793             | Connecting Hose — Fuel Rail Rear        |
| 29          | 12A697            | Sensor Assy. — Air Charge Temp.           | 61          | 9C968             | Regulator Assy. — Fuel Pressure         |
| 30          | 9A425             | Gasket — Manifold                         | 62          | 9D280             | Manifold — Fuel Injection Supply (RH)   |
| 31          | 9439              | Gasket — Intake Manifold To Cylinder Head | 63          | 9J314             | Cap — Protective                        |

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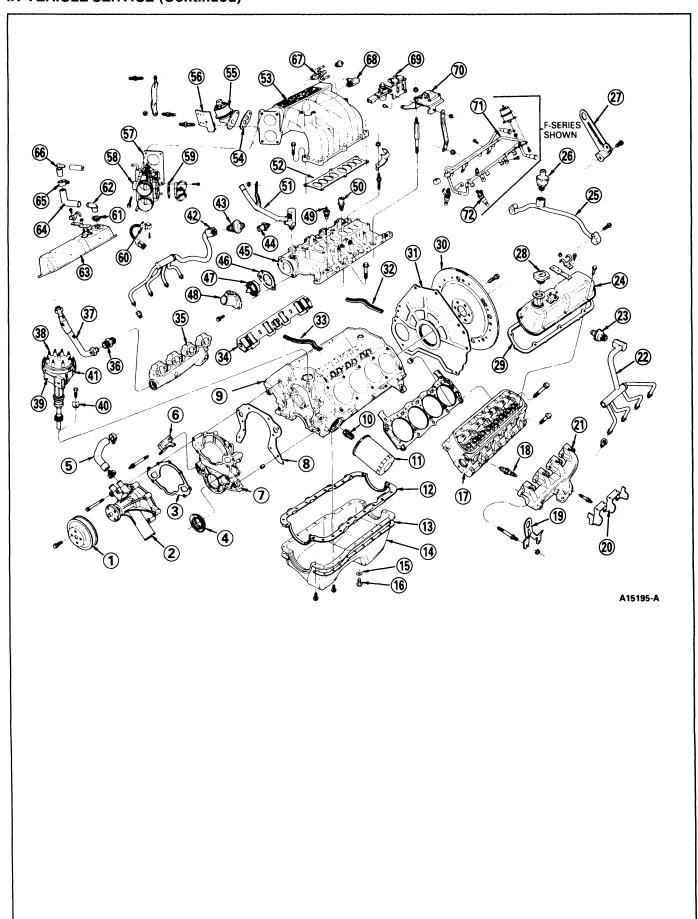


03-01B-11

# **IN-VEHICLE SERVICE (Continued)**

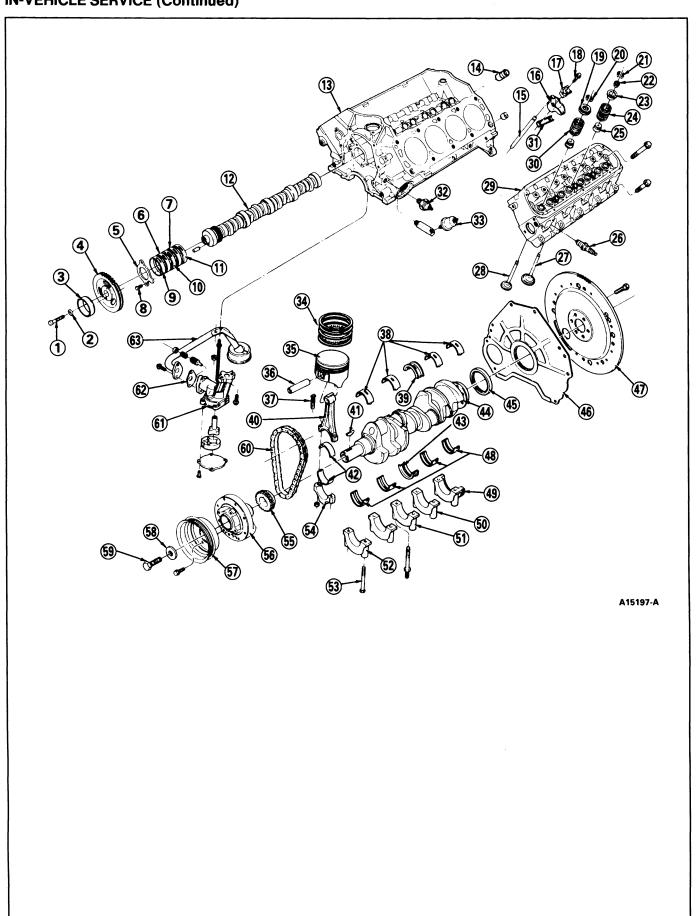
| REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                              | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                             |
|-------------|-------------------|--|-------------|-------------------|---|
| 1           | 43002             | Bolt — Camshaft Retaining                | 34          | 6505              | Valve — Exhaust                         |
| 2           | 6278              | Washer — Camshaft Sprocket               | 35          | 384918            | Bolt — Flywheel To Crankshaft           |
| 3           | 6A295             | Eccentric — Camshaft Fuel Pump           | 36          | 6375              | Flywheel Assy.                          |
| 4           | 6256              | Sprocket — Camshaft                      | 37          | 6A373             | Plate — Engine Rear                     |
| 5           | 6269              | Plate — Camshaft Thrust                  | 38          | 6701              | Packing Seal — Crankshaft Rear          |
| 6           | 6267              | Bearing — Camshaft Front Intermediate    | 39          | 6303              | Crankshaft Assy.                        |
| 7           | 6270              | Bearing — Camshaft Rear Intermediate     | 40          | 6A338             | Bearing — Main Set                      |
| 8           | 6261              | Bearing — Camshaft Front                 | 41          | 6325              | Cap — Main Bearing                      |
| 9           | 6262              | Bearing — Camshaft Center                | 42          | 6A339             | Bearing — Main Thrust                   |
| 10          | 6263              | Bearing — Camshaft Rear                  | 43          | 6327              | Cap — Main Bearing                      |
| 11          | 384940            | Pin — Dowel                              | 44          | 6330              | Cap — Main Bearing                      |
| 12          | 6250              | Camshaft                                 | 45          | 6334              | Cap — Main Bearing                      |
| 13          | 6010              | Block Assy.                              | 46          | 6329              | Cap — Main Bearing                      |
| 14          | 6A008             | Dowel — Cylinder Head To Cylinder Block  | 47          | 384664            | Bolt — Crankshaft Main Bearing Cap      |
| 15          | 6500              | Tappet Assy. — Valve                     | 48          | 6211              | Bearing — Connecting Rod                |
| 16          | 6565              | Rod — Valve Push                         | 49          | 388907            | Key — Woodruff                          |
| 17          | 6A588             | Fulcrum Guide                            | 50          | 6337              | Bearing — Crankshaft Main               |
| 18          | 6564              | Arm — Valve Rocker                       | 51          | 6333              | Bearing — Crankshaft Main               |
| 19          | 6A528             | Fulcrum                                  | 52          | 6148              | Ring Set — Piston                       |
| 20          | 390385            | Bolt — Rocker Arm                        | 53          | 6110              | Piston Assy.                            |
| 21          | 6A516             | Retainer — Valve Spring (Exhaust)        | 54          | 6135              | Pin — Piston                            |
| 22          | 6518              | Key — Valve Spring Retainer              | 55          | 6214              | Bolt — Conecting Rod                    |
| 23          | 6518              | Key — Valve Spring Retainer              | 56          | 6268              | Chain — Timing                          |
| 24          | 6517              | Sleeve — Valve Spring Retainer           | 57          | 6600              | Pump Assy. — Oil                        |
| 25          | 6514              | Retainer — Valve Spring                  | 58          | 6625              | Gasket Oil Pump Inlet Tube              |
| 26          | 6513              | Spring — Valve                           | 59          | 6A618             | Shaft Assy. — Oil Pump Intermediate     |
| 27          | 6A517             | Valve Stem Seal                          | 60          | 6622              | Screen, Tube and Cover Assy. — Oil Pump |
| 28          | 6571              | Seal — Valve Stem                        | 61          | 6306              | Sprocket — Camshaft                     |
| 29          | 386565            | Bolt — Cylinder Head                     | 62          | 6316              | Damper Assy. — Crankshaft               |
| 30          | 9A487             | Valve Assy. — Exhaust Air Supply Check   | 63          | 6312              | Pulley Assy. — Crankshaft               |
| 31          | 9B449             | Tube Assy. — Exhaust Air Supply Manifold | 64          | 6378              | Washer — Crankshaft Pulley Retaining    |
| 32          | 12405             | Spark Plug                               | 65          | 388813            | Bolt — Crankshaft Pulley Retaining      |
| 33          | 6507              | Valve — Intake                           |             |                   |   |

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| REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                                  | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                             |
|-------------|-------------------|--|-------------|-------------------|---|
| 1           | 8509              | Pulley — Water Pump                          | 37          | 9D477             | Tube — Exhaust Recirculating Valve      |
| 2           | 8501              | Pump Assy. — Water                           | 38          | 12160             | Cap — Distributor                       |
| 3           | 8507              | Gasket — Water Pump Housing                  | 39          | 12A332            | Ignition Module — TFI                   |
| 4           | 6700              | Seal — Cylinder Front Cover Oil              | 40          | 12170             | Clamp — Distributor                     |
| 5           | 8A506             | Hose — Water Pump                            | 41          | 12A217            | Adaptor — Distributor Assy.             |
| 6           | 6023              | Pointer — Timing                             | 42          | 9B445             | Manifold — Exhaust Air Supply           |
| 7           | 6059              | Cover Assy. — Cylinder Front                 | 43          | 9A487             | Valve Assy. — Exhaust Air Supply Check  |
| 8           | 6020              | Gasket — Cylinder Front Cover                | 44          | 12A648            | Sensor Assy. — EEC Coolant Temperature  |
| 9           | 6010              | Block Assy.                                  | 45          | 9K461             | Lower Intake Manifold Assy.             |
| 10          | 6890              | Insert — Oil Filter Mounting                 | 46          | 8255              | Gasket — Water Outlet Connection        |
| 11          | 6714              | Filter Assy. — Oil                           | 47          | 8575              | Thermostat — Water                      |
| 12          | 6710              | Gasket — Oil Pan                             | 48          | 8592              | Connection — Water Outlet               |
| 13          | 6694              | Reinforcement — Oil Pan                      | 49          | 10884             | Sensor — Water Temp. Indicator          |
| 14          | 6675              | Pan Assy. — Oil                              | 50          | 12A697            | Sensor Assy. — Air Charge Temperature   |
| 15          | 6734              | Gasket — Oil Pan Drain Plug                  | 51          | 18B402            | Tube — Heater Hot Water                 |
| 16          | 6730              | Plug — Oil Pan Drain                         | 52          | 9H486             | Gasket — Intake Manifold Upper          |
| 17          | 6049              | Head — Cylinder                              | 53          | 9424              | Manifold — Intake                       |
| 18          | 12405             | Spark Plug                                   | 54          | 9D476             | Gasket — EGR Valve Assy.                |
| 19          | 17A084            | Lifting Eye                                  | 55          | 9F483             | Valve Assy. — EGR Pressure External     |
| 20          | 12A087            | Heat Shield                                  | 56          | 14A163            | Retainer — Wiring Harness               |
| 21          | 9431              | Manifold — Exhaust (LH)                      | 57          | 9E936             | Gasket — Air Intake Charge Throttle     |
| 22          | 9B446             | Manifold — Exhaust Air Supply                | 58          | 9E926             | Body Assy. — Air Intake Charge Throttle |
| 23          | 9A487             | Valve Assy. — Exhaust Air Supply Check       | 59          | 9F670             | Gasket — Air By-Pass Valve              |
| 24          | 6A505             | Cover Assy. — Valve Rocker Arm (LH)          | 60          | 9B989             | Potentiometer Assy. — Throttle          |
| 25          | 9B449             | Tube Assy. — Tube Assy. — Exhaust Air Supply | 61          | 6K780             | Grommet — PCV                           |
|             |                   | Manifold                                     | 62          | 6762              | Elbow — PCV                             |
| 26          | 9A487             | Valve Assy. — Exhaust Air Supply Check       | 63          | 6582              | Cover Assy. — Valve Rocker Arm (RH)     |
| 27          | 17K004            | Lifting Eye                                  | 64          | 6A886             | Extension Tube — PCV                    |
| 28          | 6766              | Cap Assy. — Oil Filler and Breather          | 65          | 389772            | Clamp                                   |
| 29          | 6584              | Gasket — Valve Rocker Arm Cover              | 66          | 6B890             | Valve Assembly — PCV                    |
| 30          | 6375              | Flywheel Assy.                               | 67          | 9D446             | Tree — Vacuum                           |
| 31          | 6A373             | Plate Assy. — Engine Rear                    | 68          | 9A474             | Fitting and Cap Assy. — Intake Manifold |
| 32          | 9A424             | Gasket — Manifold Rear                       | 69          | 9S429             | Solenoid Assy.                          |
| 33          | 9A425             | Gasket — Manifold Front                      | 70          | 12A310            | Coil — Assy.                            |
| 34          | 9439              | Gasket — Intake Manifold To Cylinder Head    | 71          | 9F793             | Manifold — Fuel Injection Supply        |
| 35          | 9430              | Manifold — Exhaust (RH)                      | 72          | 9F593             | Injector Assy. — Fuel                   |
| 36          | 9F485             | Fitting — Exhaust Recirculating Valve        |             |                   |   |

CA15196-A

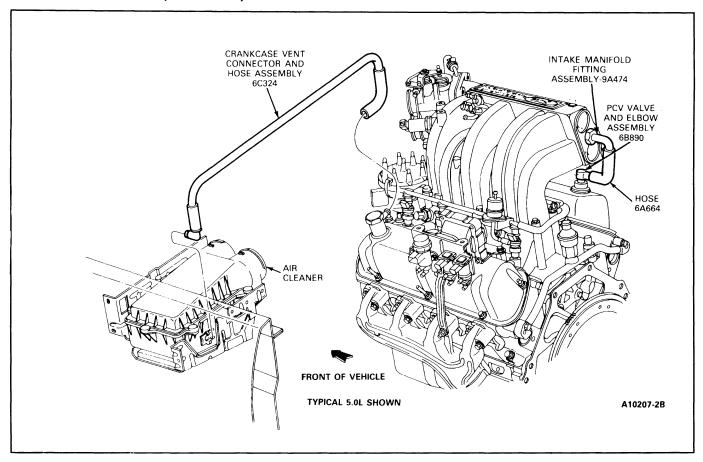


| REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                           | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                               |
|-------------|-------------------|---------------------------------------|-------------|-------------------|---|
| 1           | 43002             | Bolt                                  | 33          | 9D290             | Gauge Assy. — Oil Pressure Engine         |
| 2           | 6278              | Washer — Camshaft Sprocket            | 34          | 6148              | Ring Set — Piston                         |
| 3           | 6A295             | Eccentric — Camshaft Fuel Pump        | 35          | 6110              | Piston Assy.                              |
| 4           | 6256              | Sprocket — Camshaft                   | 36          | 6135              | Pin — Piston                              |
| 5           | 6269              | Plate — Camshaft Thrust               | 37          | 6214              | Bolt — Connecting Rod                     |
| 6           | 6267              | Bearing — Camshaft Front Intermediate | 38          | 6333              | Bearing — Crankshaft Main                 |
| 7           | 6270              | Bearing — Camshaft Rear Intermediate  | 39          | 6337              | Bearing — Crankshaft Main                 |
| 8           | 390392            | Bolt — Camshaft Thrust Plate          | 40          | 6200              | Rod Assembly — Connecting                 |
| 9           | 6261              | Bearing — Camshaft Front              | 41          | 394230            | Key — Woodruff                            |
| 10          | 6262              | Bearing — Camshaft Center             | 42          | 6211              | Bearing — Connecting Rod                  |
| 11          | 6263              | Bearing — Camshaft Rear               | 43          | 6A339             | Bearing — Main Thrust                     |
| 12          | 6250              | Camshaft                              | 44          | 6300              | Crankshaft Assy.                          |
| 13          | 6010              | Block Assy.                           | 45          | 6701              | Packing Seal — Crankshaft Rear            |
| 14          | 6500              | Tappet Assy. — Valve                  | 46          | 6A373             | Plate — Engine Rear                       |
| 15          | 6565              | Rod — Valve Push                      | 47          | 6375              | Flywheel Assembly                         |
| 16          | 6564              | Arm — Valve Rocker                    | 48          | 6A338             | Bearing — Crankshaft Main (Except Center) |
| 17          | 6A528             | Seat — Valve Rocker Arm Fulcrum       | 49          | 6325              | Cap — Main Bearing                        |
| 18          | 390385            | Bolt — Rocker Arm                     | 50          | 6327              | Cap — Main Bearing                        |
| 19          | 6A516             | Retainer — Valve Spring (Exhaust)     | 51          | 6330              | Cap — Main Bearing                        |
| 20          | 6518              | Key — Valve Spring Retainer (Exhaust) | 52          | 6329              | Cap — Main Bearing                        |
| 21          | 6518              | Key — Valve Spring Retainer (Intake)  | 53          | 390602            | Bolt — Crankshaft Main Bearing Cap        |
| 22          | 6517              | Sleeve — Valve Spring Retainer        | 54          | 6210              | Cap — Main Bearing                        |
| 23          | 6514              | Retainer — Valve Spring (Intake)      | 55          | 6306              | Sprocket — Crankshaft                     |
| 24          | 6513              | Spring — Valve                        | 56          | 6316              | Damper Assy. — Crankshaft                 |
| 25          | 6A517             | Valve Stem Seal                       | 57          | 6312              | Pulley Assy. — Crankshaft                 |
| 26          | 12405             | Spark Plug                            | 58          | 6378              | Washer — Crankshaft Pulley Retaining      |
| 27          | 6507              | Valve — Intake                        | 59          | 376706            | Bolt                                      |
| 28          | 6505              | Valve — Exhaust                       | 60          | 6268              | Chain — Timing                            |
| 29          | 6049              | Head — Cylinder                       | 61          | 6600              | Pump Assy. — Oil                          |
| 30          | 6513              | Spring — Valve                        | 62          | 6625              | Gasket — Oil Pump Inlet Tube              |
| 31          | 6A588             | Fulcrum Guide                         | 63          | 6622              | Screen, Tube and Cover Assy. — Oil Pump   |
| 32          | 9278              | Gauge Assy. — Oil Pressure Engine     |             |                   |   |

CA15198-A

# **Crankcase Ventilation System**

Typical crankcase ventilation system components for the various applications are shown. Any modifications of the system prior to the first sale and registration of the vehicle is subject to Federal (U.S.A.) law and to the penalties under the laws of some states thereafter.



### Non-A/C and Non-Super Cooling

#### Removal

- Disconnect crankcase vent hose from LH rocker cover fill tube nipple.
- 2. Remove the air cleaner and intake duct assembly.
- Disconnect the crankcase vent tube from the rear of upper intake manifold.

# Installation

- 1. Install the air cleaner and intake duct assembly.
- Insert the elbow into the grommet in the oil filler cap. Connect the crankcase vent rear hose to the elbow and the air cleaner.
- Start the engine and check for leaks.

### A/C and Super Cooling

#### Removal

- Disconnect the crankcase vent front hose from the air cleaner.
- Remove the air cleaner and intake duct assembly. If so equipped, disconnect the oil filler pipe hose from the LH rocker arm cover.
- Disconnect the crankcase vent rear hose from the rear of the upper intake manifold.

### Installation

- Install the air cleaner and intake duct assembly. If so equipped, connect the oil filler pipe hose to the LH rocker arm cover.
- Connect the crankcase vent front hose to the cleaner and the oil filler tube.
- 3. Start the engine and check for leaks.

#### **Electronic Fuel Injection**

Refer to Section 03-04A for removal and installation of EFI components.

## Engine Front Supports

The front supports are located on each side of the cylinder block. The procedures given apply to either a RH or LH installation. However, a sheet metal shield on the LH side only is used on F-Series trucks.

# F-150 — F-350 and Bronco

#### Removal

1. Remove the bolts attaching the fan shroud to the radiator and position the shroud over the fan.

- Remove the nut and washer attaching the support insulator to the chassis bracket.
- 3. Raise the engine.
- Remove the bolts and lockwashers attaching the support insulator to the cylinder block and remove the insulator and heat shield (LH side only).

#### Installation

- Position the support insulator and heat shield (LH side only) to the cylinder block and install the attaching bolts and lockwashers loosely.
- Carefully lower the engine, guiding the support insulator stud into the support bracket. Tighten the insulator-to-engine bolts to 68-94 N-m (50-70 ft-lb).
- Install the insulator-to-chassis bracket nut and washer. Tighten the nut to 88-115 N·m (65-85 ft-lb).
- Install the fan shroud attaching bolts.

#### E-150 - E-350

#### Removal

- Remove fan shroud bolts. Remove the insulator-to-support nuts.
- Position transmission jack under engine assembly. Lift engine assembly and then remove starter. Refer to Section 03-06A, Starter—Positive Engagement.
- Remove insulator-to-engine bolts and alternator splash shield. Remove the insulators.

#### Installation

- Clear clots in engine block of debris using a 7 / 16-14 bottoming tap.
- Install insulators to engine using new bolts. Tighten to 68-96 N·m (50-70 ft-lb).
- Install starter. Refer to Section 03-06A, Starter—Positive Engagement. Then, lower the engine assembly. Move transmission jack out of the way.
- Replace the insulator-to-support nuts and tighten to 68-95 N-m (50-70 ft-lb). Install fan shroud and bolts.

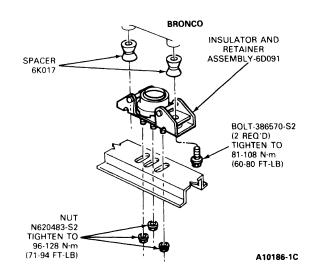
# **Engine Rear Supports**

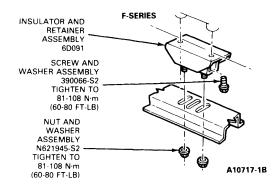
The procedures apply to F-150—F-350 and Bronco and E-150—E-350 center mount.

#### F-150-F-350/Bronco

#### Removal

 Remove the support insulator-to-crossmember attaching nuts.  Raise the transmission with a floor jack to provide clearance and remove the two bolts, insulator and spacers.





#### Installation

- 1. Position the support insulator and spacers.
- Install the support insulator-to-transmission extension housing bolts. Tighten the bolts to 81-108 N-m (60-80 ft-lb). Lower the transmission.
- Install the support insulator-to-crossmember attaching nuts. Tighten the nuts to 68-94 N-m (50-70 ft-lb).

## E-150-E-350

#### Removal

CAUTION: On 138 inch wheel base vehicles. First remove the fuel reservoir to eliminate any part damage due to removal of rear transmission support crossmember. Refer to Section 10-01A, Fuel Tank, Pump Lines and Filters—Gasoline Engines.

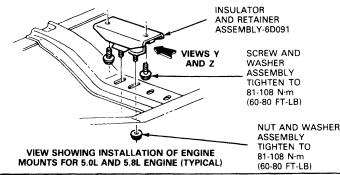
- 1. Raise the vehicle on a hoist.
- Remove the insulator support nuts securing the rear insulator support to the frame crossmember.

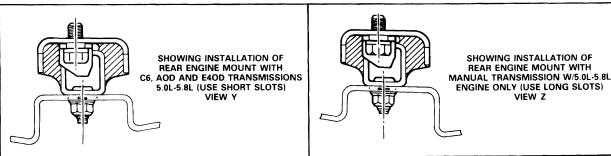
 Raise the transmission with Transmission Jack, Rotunda 066-00017 or equivalent, so that the insulator support clears the frame.

**ECONOLINE** 

MODELS

 Remove the insulator support bolts securing the rear insulator support to the transmission, then remove the insulator.





A6536-E

#### Installation

- Position the insulator support, then install the bolts securing the insulator support to the transmission. Tighten the bolts to 68-94 N·m (50-70 ft-lb).
- Lower the jack supporting the transmission and align the insulator support bolt holes with the holes in the frame assembly.
- Install the bolts and nuts securing the insulator support to the frame. Tighten to 68-94 N·m (50-70 ft-lb).
- 4. Lower the vehicle.

## Oil Pan

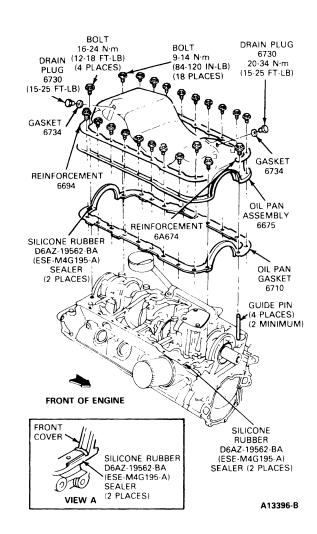
F-150-F-350/Bronco

#### Removal

1. Remove the bolts attaching the fan shroud to the radiator and position the shroud over the fan.

- 2. Remove the upper intake manifold
- Remove the nuts and lockwashers attaching the engine support insulators to the chassis bracket.
- If equipped with an automatic transmission, disconnect the oil cooler line at the LH side of the radiator.
- 5. Remove exhaust system.
- 6. Raise the engine and place wood blocks securely under the engine supports.
- 7. Drain the crankcase.
- 8. Support transmission with jack stand and remove transmission crossmember.
- 9. Remove the oil pan attaching bolts and lower the oil pan onto the crossmember.
- Remove the two bolts attaching the oil pump pickup tube to the oil pump. Remove nut attaching oil pump pickup tube to the number 3 main bearing cap stud. Lower the pickup tube and screen into the oil pan.

11. Remove the oil pan from the vehicle.



## Installation

- Clean oil pan, inlet tube and gasket surfaces. Inspect the gasket sealing surface for damages and distortion due to overtightening of the bolts. Repair and straighten as required.
- Position a new oil pan gasket to the cylinder block.
- Position the oil pickup tube and screen to the oil pump, and install the lower attaching bolt and gasket loosely. Install nut attaching to number 3 main bearing cap stud.
- 4. Install the upper pickup tube bolt. Tighten the pickup tube bolts to specifications.
- Position the oil pan to the cylinder block and install the attaching bolts. Tighten to 13-14 N-m (9-11 ft-lb).
- Install the transmission crossmember and remove jack stand.

- 7. Raise the engine and remove the wood blocks. Lower the engine and install the insulator-to-chassis bracket nuts and washers. Tighten the nuts to 73-100 N·m (54-75 ft-lb).
- 8. Install the exhaust system.
- If equipped with an automatic transmission, connect the oil cooler line at the radiator.
- Install the upper intake manifold.
- 11. Install the fan shroud attaching bolts.
- 12. Fill the crankcase with the proper grade and quantity of engine oil. Install the oil dipstick. Start the engine and operate it until it reaches normal operating temperature, then check for leaks.

#### E-150 - E-350

#### Removal

- Open hood and disconnect battery. Open door and remove engine cover. Remove air cleaner. Drain cooling system. Refer to Section 03-03, Engine Cooling.
- If so equipped, release belt tensioner and remove belt. Remove power steering pump and bracket and position out of way. If so equipped, remove A/C compressor retainers and clutch wire and position compressor and bracket out of way. Refer to Section 12-03B, A/C-Heater System—Econoline.
- Disconnect radiator upper hose. Remove fan shroud bolts and oil filler tube. Remove oil dipstick-to-exhaust manifold bolt. Raise vehicle on hoist.
- 4. Remove splash shield under alternator. If so equipped, disconnect transmission cooler lines at radiator. Disconnect radiator lower hose.
- Disconnect fuel line at fuel rail. Remove engine mount nuts. Drain crankcase. Remove the dipstick tube from oil pan. Disconnect muffler inlet pipe from manifolds.
- If so equipped, remove automatic transmission dipstick and tube. Disconnect manual linkage at transmission. Remove center driveshaft support and remove driveshaft from transmission.
- 7. Place a transmission jack under the oil pan and insert a wooden block between the pan and jack. The engine and transmission assembly will pivot around the rear engine mount. The engine assembly must be raised 102mm (4-inches) measured from the front motor mounts. The engine must remain centered in the engine compartment to obtain this much lift.
- 8. Raise the engine and transmission assembly. Insert wood blocks to support engine in uppermost position.

 Remove the oil pan attaching bolts and lower the oil pan. Unbolt the oil pump and pickup tube and lay in pan (except on 5.8L (351 CID) W-V-8 E-150—E-350 models). Remove nut attaching pickup tube to number 3 main bearing cap stud. Remove oil pan from vehicle.

#### Installation

- Clean oil pan, pickup tube, pump and gasket surfaces. Inspect gasket sealing surfaces for damage or distortion from overtightened bolts.
- Position new gasket and seals to block. Position pan with pump to engine and install pump. Install nut attaching pickup tube to number 3 main bearing cap stud. Install oil pan and tighten attaching bolts to 13-14 N-m (9-11 ft-lb). Install dipstick tube.
- Position transmission jack, raise engine, remove wood blocks, lower engine and remove jack. Install front insulator attaching nuts and tighten to 68-95 N·m (50-70 ft-lb).
- Install driveshaft and center driveshaft support. Connect manual linkage at transmission. Install muffler inlet pipe. Tighten nuts to 34-52 N·m (25-38 ft-lb). Install transmission filler tube. Connect radiator lower hose.
- If so equipped, connect transmission cooler lines to radiator. Connect fuel line to pump fuel rail. Install alternator splash shield. Lower vehicle on hoist.
- Install radiator shroud and connect radiator upper hose. If so equipped, install power steering pump and bracket. Install bolt attaching dipstick tube to exhaust manifold.
- If so equipped, install A/C compressor. Refer to Section 12-03B A/C-Heater System—Econoline. Position belt according to belt decal, reset auto tensioner. Refer to Section 03-05, Engine Accessory Drive.
- Install oil filler tube and install air cleaner. Fill crankcase and fill and bleed cooling system. Refer to Section 03-03, Engine Cooling.
- 9. Connect battery. Start Engine and check for leaks. Install engine cover. Close hood and door.

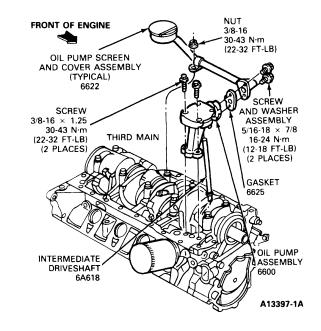
## Oil Pump

#### Removal

NOTE: On E-150—E-250 5.0L (302 CID) V-8 engine vehicles the oil pump and oil pan must be removed and installed together. Refer to the E-150—E-350 Oil Pan Removal and Installation procedures.

## F-150 - F-350 and Bronco

- Remove the oil pan and related parts as outlined under Oil Pan Removal.
- 2. Remove the oil pump inlet tube and screen assembly.
- 3. Remove the oil pump attaching bolts and intermediate driveshaft.

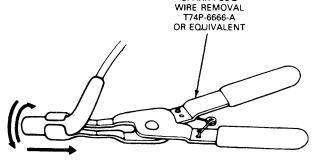


## Installation

- Prime the oil pump by filling the inlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.
- Position the intermediate driveshaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.
- 3. With the stop properly positioned, insert the intermediate driveshaft into the oil pump. Install the pump and shaft as an assembly. Do not attempt to force the pump into position if it will not seat readily. The driveshaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate driveshaft into a new position. Tighten the oil pump attaching screws to 30-43 N·m (22-32 ft-lb).
- Clean and install the oil pump inlet tube and screen assembly.
- 5. Install the oil pan and related parts as outlined under Oil Pan Installation.

# Valve Rocker Arm Cover and Rocker Arm Removal

- Remove air cleaner and intake duct assembly, including the closed crankcase ventilation hoses and tubes, remove coil and solenoid brackets. For removal of RH rocker cover, remove lifting eye and Thermactor tube.
- 2. Remove oil filler pipe host from LH rocker arm cover, if so equipped.
- Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the moulded cap using Spark Plug Wire Remover T74P-6666-A or equivalent. Remove wires and bracket assemblies from the rocker arm cover attaching stud and position out of the way.

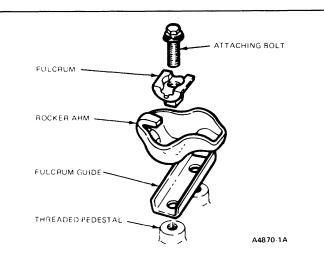


SPARK PLUG

TWIST AND PULL

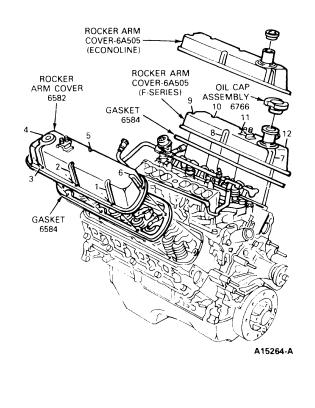
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- Remove vacuum harness and electrical connectors to the vacuum solenoids mounted on the rocker arm covers, if so equipped, and position out of the way.
- Disconnect evaporative system hoses from the canister or the chassis, if so equipped, and position out of the way.
- Remove thermactor air supply hose, if so equipped.
- Remove rocker arm cover bolts and remove rocker arm covers.
- Remove the valve rocker arm bolt, fulcrum seat and rocker arm.



#### Installation

- Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stem, the fulcrum seat and socket.
- Install the fulcrum guide, valve rocker arm, fulcrum seat and bolt. Tighten to 25-32 N·m (18-25 ft-lb).
- Clean and inspect gasket surfaces. Inspect the gasket sealing surface from damage and distortion due to overtightening of the bolts. Repair and straighten as required. Place the new gaskets in the covers, making sure that the tabs of the gasket engage the notches provided in the cover.

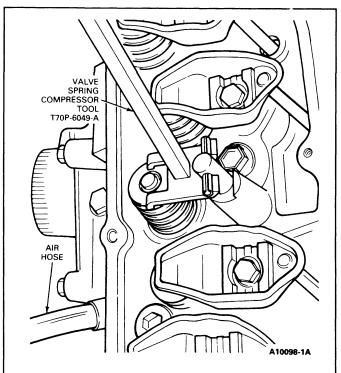


- Position the cover(s) on the cylinder head(s). Install the cover bolts and tighten to 13.6-17.6
   N·m (10-13 ft-lb). Wait two minutes, then tighten bolts again to same specification.
- Retighten all intake manifold bolts to 32-33 N-m (23-25 ft-lb) using sequence shown. Install vacuum harness bracket and attaching nut. Tighten to 17-24 N-m (12-18 ft-lb).
- Reconnect vacuum harnesses and electrical connectors to the vacuum solenoids on the arm covers, if so equipped.
- Connect spark plug wires and bracket assembly to attaching stud on rocker arm cover and connect wires at spark plugs.
- Connect thermactor air supply hose, if so equipped.
- Connect oil filler pipe hose to LH rocker arm, if so equipped.
- Install the closed crankcase ventilation hoses or tubes.

# Valve Spring, Retainer and Stem Seal Removal

Broken valve spring or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damages to valve or valve seat has not occurred.

- Remove rocker arm cover. Refer to Valve Rocker Arm Cover Removal and Installation.
- Remove the applicable spark plug and bring the piston to the top of the bore to prevent accidental loss of the valve into the cylinder.
- Remove the valve rocker arm fulcrum bolts, fulcrum seats, valve rocker arms and push rods from the applicable cylinder.
- Install an air line with an adapter in the spark plug hole and apply air pressure to the cylinder. Failure of the air pressure to hold the valve(s) in the closed position is an indication of valve seat damage and requires removal of the cylinder head.
- Install the fulcrum bolt and position the Valve Spring Compressor Tool T70P-6049-A or equivalent as shown. Compress the valve spring and remove the retainer locks, spring retainer, sleeve and valve spring.

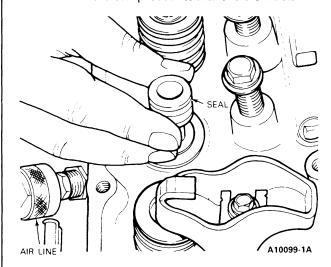


- Remove and discard the valve stem seal.
- 7. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.
- 8. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head. Refer to Section 03-00, Engine—Gasoline—General Service.

#### Installation

 If the condition of the valve proved satisfactory, lubricate the valve stem with engine oil of quality recommended in the Owner's Manual. Hold the valve in the closed position and apply air pressure within the cylinder.

 Install a new valve stem seal on the valve guide. Seal must be bottomed on guide. Place the spring in position over the valve and install the valve spring retainer and sleeve. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and fulcrum bolt.



- Lubricate the push rod ends with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent and install the push rod. Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent to the tip of the valve stem.
- Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A), or equivalent to the rocker arms and fulcrum. Install the valve rocker arms, fulcrum and fulcrum bolts. Tighten to 25-33 N·m(18-25 ft-lb).
- Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
- 6. Clean and install the rocker arm cover.

#### Intake Manifold

#### Removal

- Drain the cooling system. Remove the air cleaner intake duct assembly, including the crankcase ventilation hose.
- Disconnect the accelerator cable and speed control linkage, if so equipped, from the throttle body. Remove the accelerator cable bracket. Disconnect the automatic transmission kickdown rod at the throttle body.
- 3. Disconnect the high-tension lead and wires from the coil.

- 4. Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the moulded cap using Spark Plug Wire Remover T74P-6666-A or equivalent. Remove the wires and bracket assembly from the rocker arm cover attaching stud. Remove the distributor cap and spark plug wires as an assembly.
- Remove the throttle body fuel inlet line (push-connect fittings). Refer to Section 10-01A, Fuel Tank, Pump Lines and Filters—Gasoline Engines for push-connect fitting removal.
- Disconnect the distributor vacuum hoses from the distributor, if so equipped, or EEC distributor connection. Remove the distributor hold-down bolt and remove the distributor. Disconnect evaporative hoses.
- 7. Disconnect the radiator upper hose from the coolant outlet housing, and the water temperature sending unit wire at the sending unit. Remove the heater hose from the intake manifold.
- 8. Loosen the clamp on the water pump bypass hose at the coolant outlet housing and slide the hose off the outlet housing.
- Disconnect the crankcase vent hose at the valve rocker arm cover.
- Remove the intake manifold and throttle body as an assembly. It may be necessary to pry the intake manifold away from the cylinder heads. Remove the intake manifold gaskets and seals.
- 11. Remove upper intake manifold and throttle body as an assembly. Then, remove lower intake manifold assembly. It may be necessary to pry the intake manifold away from the cylinder heads. Remove the intake manifold gaskets and seals. Discard the intake manifold attaching bolt sealing washer.
- 12. If the manifold assembly is to be disassembled, identify all vacuum hoses before disconnecting them. Remove the coolant outlet housing gasket and thermostat. Remove the ignition coil, temperature sending unit, throttle body, spacer, gasket, vacuum fitting, accelerator retracting spring bracket.

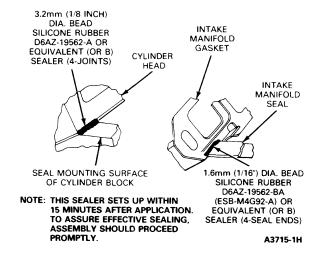
#### Installation

1. If the intake manifold assembly was disassembled, install the temperature sending unit (threads coated with electrical conductive sealer), ignition coil, throttle body, spacer, gaskets, vacuum fitting, accelerator retracting spring bracket. Position the thermostat in the coolant outlet housing. Coat the new thermostat gasket with water-resistant sealer such as Ford Perfect Seal B5A-19554-A (ESR-M18P2-A), or equivalent, and position it on the coolant outlet housing. Install the coolant outlet housing. Tighten to 13-16 N·m (9-12 ft-lb). Connect all vacuum hoses.

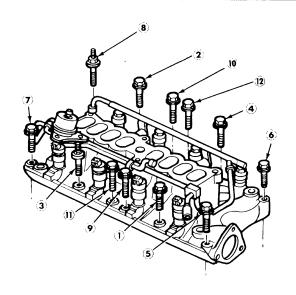
- Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block using a solvent such as Ford Spot Remover B7A-19521-A (ESR-M5B197-A), or equivalent. Apply a 3.2mm (1/8 inch) bead of silicone rubber D6AZ-19562AA or BA (ESB-M4G92-A) or equivalent at the points shown.
- Apply a 1.6mm (1/16 inch) bead of RTV sealer to the outer end of each intake manifold seal for the full width of the seal (4 places).

NOTE: This sealer sets up in 15 minutes, so it is important that assembly by completed promptly. Do not drip any sealer into the engine valley.

Position the seals on the cylinder block and new gaskets on the cylinder heads with trademark toward cylinder head with the gaskets interlocked with the seal tabs. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.



- 4. Carefully lower the intake manifold into position on the cylinder block and cylinder heads. After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If the seals are not in place, remove the intake manifold and position the seals.
- Ensure holes in the manifold gaskets and manifold are in alignment. Install the intake manifold attaching nuts and bolts. Tighten all nuts and bolts in sequence to 32-33 N·m (23-25 ft-lb). After ten minutes retighten to the same specifications.



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- 6. Install the water pump bypass hose on the coolant outlet housing. Slide the clamp into position and tighten the clamp.
- Connect the radiator upper hose. Install the heater hose and connect the hose to the intake manifold.
- 8. Install the fuel inlet line.
- 9. Hook up vehicle chassis fuel supply and return lines to engine fuel rails.
- Rotate the crankshaft damper until the No. 1
  piston is on TDC at the end of the compression
  stroke. Install the distributor. Refer to Section
  03-07, Ignition System General Service for
  breakerless ignition systems.
- 11. Install the distributor cap, coil and solenoid brackets. Connect the spark plug wires and bracket assembly to attaching stud on rocker arm cover and connect the wires to the plugs.
- Connect crankcase vent hose. Connect the high-tension lead and coil wires.
- 13. Connect accelerator cable and accelerator cable bracket. Connect speed control cable, if so equipped. Connect the automatic transmission kickdown rod/cable at the throttle body, if so equipped. Reconnect evaporative canister hoses.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling.

WARNING: DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

 Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses or EEC connector, if so equipped.

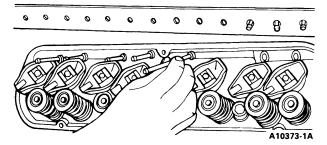
- 16. Operate the engine at fast idle and check all hose connections and gaskets for leaks. Operate the engine until engine temperatures have stabilized and adjust the engine idle speed and idle fuel mixture to specifications on engine decal (5.0L EFI/5.8L EFI speeds/mixture controlled by computer). Re-tighten the intake manifold bolts in sequence to 32-33 N·m (23-25 ft-lb).
- Adjust the transmission throttle linkage. Refer to Section 10-02, Throttle Linkage for adjustment procedure. Install the air cleaner and intake duct assembly, including the closed crankcase ventilation hose.

# Tappet

Before replacing a hydraulic tappet for noisy operation, verify the noise is not caused by improperly adjusted valve-to-rocker arm clearance or by worn rocker arms or push rods.

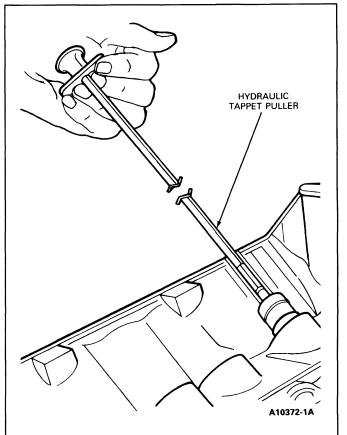
#### Removal

- Remove the intake manifold and related parts following procedures under Intake Manifold Removal.
- Disconnect thermactor air supply hose at the air pump and place it out of the way.
- Remove the valve rocker arm cover, then loosen the valve rocker arm fulcrum bolts and rotate the rocker arms to the side.
- 4. Remove the valve push rods in sequence so that they can be installed in their original positions.



 Using Hydraulic Tappet Puller T70L-6500-A or equivalent, shown, remove the tappets and place them in a rack so that they can be installed in their original bores.

If necessary to disassemble a tappet, refer to Tappet Disassembly and Assembly.



#### Installation

Tappets and bores are to be lubricated with engine oil of the quality recommended in the Owner's Manual before installation.

- Clean the external surfaces and install the tappets in the bores from which they were removed using Hydraulic Tappet Puller T70L-6500-A or equivalent. If a new tappet(s) is being installed, check the new tappet(s) for a free fit in the bore in which it is to be installed. Lubricate the tappet(s) and bore(s) with recommended quality engine oil before inserting the tappet.
- Lubricate the ends of the push rods with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent and install the push rods in their original positions. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the valve stem tip.
- Lubricate the rocker arms and fulcrum seats with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent and position the rocker arms over the push rods. Tighten rocker arm fulcrum bolts to 25-33 N·m (18-25 ft-lb).
- 4. Install the valve rocker arm covers.
- 5. Reconnect thermactor air supply hose.
- Install the intake manifold following procedures under Intake Manifold Installation.

#### Cylinder Heads

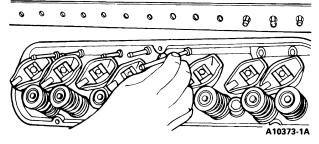
If a cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, and reface the valves. Refer to Section 03-00, Engine—Gasoline—General Service. Check all assembly clearances before assembling the new or used parts to the new cylinder head.

## Removal

- Remove the intake manifold and throttle body as an assembly following the procedure under Intake Manifold Removal.
- 2. Remove the rocker arm cover(s).
- If the RH cylinder head is to be removed, lift tensioner and remove drive belt then remove the alternator and air pump mounting bracket complete with accessories. Swing the alternator down and out of the way. Remove the ignition coil (E-150—E-350) and air cleaner inlet duct from the LH cylinder head assembly.

If the LH cylinder head is being removed, remove the air conditioning compressor/power steering bracket at the front of the cylinder head, complete with accessories. Remove oil dipstick and tube assembly and speed control bracket, if so equipped.

- Disconnect the exhaust manifold(s) from the muffler inlet pipe(s).
- Loosen the rocker arm fulcrum bolts so that the rocker arms can be rotated to the side. Remove the push rods in sequence so that they may be installed in their original positions.



- On E-150—E-350, remove the bolts holding the thermactor air supply manifold to the rear of the cylinder head and disconnect the hose at the air pump. Remove hose, pump valve and air supply manifold as an assembly.
- On F-150—F-350 and Bronco, disconnect the thermactor air supply hoses at the check valves and plug the check valve.
- Install the cylinder head holding fixtures. Remove the cylinder head attaching bolts and lift the cylinder head off the block. Remove and discard the cylinder head gasket.

#### Installation

- Clean the cylinder head, intake manifold, valve rocker arm cover and cylinder head gasket surfaces. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces. Refer to Section 03-00, Engine—Gasoline—General Service.
- A specially treated composition gasket is used.
   Do not apply sealer to a composition gasket.
   Position the new cylinder head gasket over the cylinder dowels on the block. Position the cylinder head on the block and install the attaching bolts. Remove the holding fixtures.
- The cylinder head bolts are tightened in three progressive steps, for the 5.8L EFI (351 CID) W-V-8, and in two steps for the 5.0L EFI (302 CID) V-8. Tighten all the bolts in sequence to:

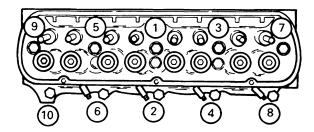
(For the 5.8L (351 CID) W-V-8)

- first step-115 N·m (85 ft-lb)
- second step—129 N·m (95 ft-lb)
- third step-143-151 N·m (105-112 ft-lb)

(For the 5.0L (302 CID) EFI V-8)

- first step-75-88 N·m (55-65 ft-lb)
- second step—88-97 N·m (65-72 ft-lb)

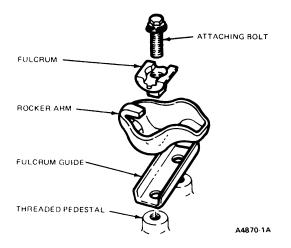
When cylinder head bolts have been tightened following this procedure, it is not necessary to retighten the bolts after extended operation. However, the bolts may be checked and retightened if desired.



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- 4. Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air. Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Visually check the push rods for straightness or check push rod runout with a dial indicator. Refer to Section 03-00, Engine—Gasoline—General Service. If runout exceeds the maximum limit at any point, discard the rod. Do not attempt to straighten push rods.
- Lubricate the end of the push rods with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A), or equivalent and install them in their original positions. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the valve stem tips.

 Lubricate the rocker arms and fulcrum seats with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent, then install the rocker arms.



- Position a new gasket(s) on the muffler inlet pipe(s), if so required. Connect the exhaust manifold(s) at the muffler inlet pipe(s). Tighten the nuts to 34-52 N·m (25-38 ft-lb).
- If the right cylinder head was removed, swing the air pump alternator bracket and accessories, ignition coil (E-150—E-250) and air cleaner inlet duct on the RH cylinder head. Refer to Section 03-05, Engine—Accessory Drive to install drive belt and auto tensioner.
  - If the LH cylinder head was removed, install the power steering and air conditioning compressor bracket, with accessories at the front of the cylinder head. Install the oil dipstick and tube assembly and speed control bracket, if so equipped.
- Clean the valve rocker arm cover gasket surfaces. Secure the new gaskets in the covers with gasket cement to ensure proper hole alignment. Install the valve rocker arm cover(s).
- Install the intake manifold and related parts following the procedure under Intake Manifold Installation.
- 11. Install the thermactor air supply manifold at the rear of the cylinder heads. Reconnect the air supply hose to the air pump (F-150), unplug the check valve and connect the thermactor air supply hose.

#### **Exhaust Manifolds**

#### Removal

- Remove air cleaner and intake duct assembly, including the crankcase ventilation hose.
- Remove bolts attaching the air cleaner inlet duct (E-150—E-350), if so equipped.

- 3. Disconnect muffler inlet pipes.
- 4. Remove the exhaust manifold heat shields, if so equipped, attaching bolts and flat washers. On the LH exhaust manifold remove oil dipstick tube assembly and speed control bracket and exhaust heat control valve, if so equipped. Then, remove the exhaust manifold.

#### Installation

- Clean the mating surfaces of the exhaust manifold(s) and cylinder head(s). Clean the mounting flange spherical seat of the exhaust manifold(s) and muffler inlet pipe(s).
- Position the exhaust manifold(s) on the cylinder head(s) and install attaching bolts and flat washers. On the LH exhaust manifold install oil dipstick tube assembly and the speed control bracket, if so equipped. Working from the center to the ends, tighten the bolts to 25-33 N-m (18-24 ft-lb).
- Place a new gasket(s), if so equipped, on the muffler inlet pipe(s). Position the muffler inlet pipe(s) and exhaust heat control valve, if so equipped, into the manifold(s). Install and tighten the attaching nuts to 34-52 N·m (25-38 ft-lb).
- Install air cleaner and intake duct assembly, including the crankcase ventilation hose.

## Water Pump

#### F-150-F-350/Bronco

## Removal

- 1. Drain the cooling system. Refer to Section 03-03, Engine Cooling.
- 2. Loosen the bolts on the fan clutch.
- Remove the bolts securing the fan shroud to the radiator, if so equipped. Position the shroud over the fan. Remove the auto-tensioned drive belt.
- Disconnect the radiator lower hose, heater hose and bypass hose at the water pump. Remove the fan, clutch and pulley. Remove the fan shroud, if so equipped.
- Remove the A/C compressor/power steering bracket and accessories to clear the stud bolt on the water pump housing.

#### Installation

# Before a water pump is installed, check it for damage. If it is damaged, replace it.

- Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.
- Position a new gasket, coated on both sides with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A), or equivalent, on the cylinder front cover; then, install the pump.

- Install the attaching bolts. Tighten bolts to 17-24 N·m (12-18 ft-lb).
- 4. Install the A/C compressor/power steering bracket over the stud bolt on the water pump and attach to cylinder head. Check hoses for correct routing. For Air Conditioning service refer to Section 12-03, Air Conditioning—General Service. Refer to Section 11-00, Steering General Service for power steering service.
- Position the fan shroud over the water pump, if so equipped. Install the pulley, clutch and fan. Install the drive belts with the auto belt tensioner. Refer to Section 03-05, Belt—Accessory Drive Service. Connect the radiator hose, heater hose and bypass hose. Install the fan shroud bolts, if so equipped.
- Fill and bleed the cooling system. Refer to Section 03-03, Cooling System General Service. Operate the engine until normal operating temperatures have been reached and check for leaks.

## E-150 - E-350

#### Removal

- Remove the air cleaner and intake duct assembly, including the crankcase ventilation hose.
- Drain the cooling system. Refer to Section 03-03, Engine Cooling.
- Disconnect the radiator upper hose at the engine and lower hose at the radiator. Remove the radiator attaching bolts and nuts. Remove the radiator. Refer to Section 03-03, Engine Cooling.
- 4. Remove drive belt fan, clutch and water pump pulley, if so equipped.
- Disconnect heater hose and bypass hose at water pump.
- Remove the A/C compressor/power steering pump bracket from the cylinder head and water pump stud bolt after disconnecting the A/C and power steering systems.
- 7. Remove the bolts securing the water pump to the cylinder front cover. Remove the water pump.

#### Installation

# Before a water pump is installed, check it for damage. If it is damaged, replace it.

- Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.
- Position a new gasket, coated on both sides with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent, on the cylinder front cover; then, install the pump.

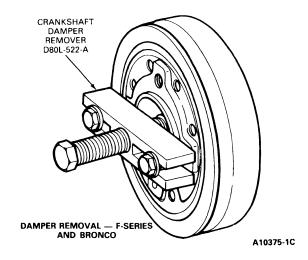
- Install the attaching bolts and tighten to 17-24 N·m(12-18 ft-lb).
- Connect the heater hose and bypass hose at the water pump.
- Connect the A/C compressor/power steering pump bracket and accessories to the cylinder head and water pump stud bolt.
- Install the water pump pulley, clutch fan and drive belt. Refer to Section 03-05, Engine—Accessory Drive
- 7. Install the radiator. Refer to Section 03-03, Engine Cooling. Connect lower hose at the radiator and upper hose at the engine.
- 8. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Operate the engine until normal operating temperatures have been reached and check for leaks.
- Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

## **Cylinder Front Cover and Timing Chain**

F-150-F-350/Bronco

#### Removal

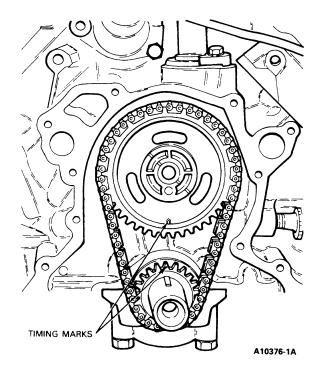
- Refer to Water Pump Removal. Perform all steps except removal of the pump. Leave it attached to the front cover.
- Remove the crankshaft pulley from the crankshaft vibration damper. Remove the damper attaching bolt and washer. Install Damper Remover D80L-522-A, Crankshaft Damper Remover T58P-6316-D, Damper Remover / Replacer Tool T79T-6316-A or equivalents on the crankshaft vibration damper and remove the vibration damper.



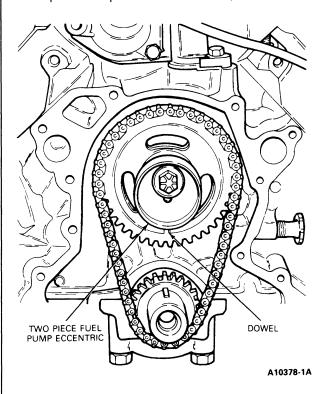
- Remove the oil pan-to-cylinder block front cover attaching bolts. Use a thin-bladed knife to cut the oil pan gasket flush with the cylinder block face prior to separating the cover from the cylinder block. Remove the cylinder front cover and water pump as an assembly.
- 4. Discard the cylinder front cover gasket.
- Check the timing chain deflection. Refer to Section 03-00, Engine—Gasoline—General Service. If deflection exceeds specifications listed at the end of this section replace the chain and sprockets.
- Crank the engine until the timing marks on the sprockets are positioned as shown.
- Remove the camshaft sprocket capscrew, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly.

#### Installation

 Position the sprockets and timing chain on the camshaft. Be sure the timing marks on the sprockets are positioned as shown.



 Install the fuel pump eccentric, washers and camshaft sprocket capscrew. Tighten the sprocket capscrew to 55-61 N·m (40-45 ft-lb).

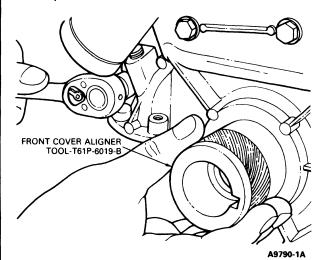


 Clean the cylinder front cover, oil pan and the cylinder block gasket surfaces. Clean the oil pan gasket surface where the oil pan and front cover fasten.

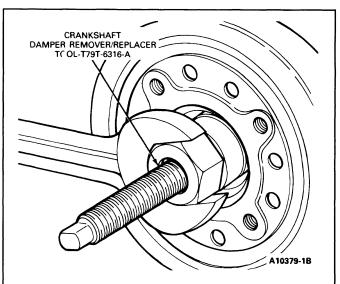
Install a new oil seal following procedures under Front Oil Seal Removal and Installation.

- 4. Lubricate the timing chain and sprockets with heavy engine oil.
- 5. Coat the gasket surface of the oil pan with sealer, then cut and position the required new gasket on the oil pan and apply sealer at the corners. Install the pan seal as required. Coat the gasket surfaces of the block and cover with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A), or equivalent, and position a new gasket on the block.
- Position the cylinder front cover on the cylinder block. Use care when installing the cover to avoid seal damage or possible gasket mislocation.

 Install the cylinder front cover-to-seal alignment using Front Cover Aligner Tool T61P-6019-B or equivalent.



- It may be necessary to force the cover downward to slightly compress the pan gasket. This operation can be facilitated by using a suitable tool at the front cover attaching hole locations.
- Coat the threads of the attaching screws with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A), or equivalent and install the screws. While pushing in on the alignment tool, tighten the oil pan-to-cover attaching screws to 17-24 N·m (12-18 ft-lb). Tighten the cover-to-cylinder block attaching screws to 17-24 N·m (12-18 ft-lb). Remove the alignment tool.
- Apply Multi-Purpose Grease DOAZ-19584-AA or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal and to the front of the crankshaft for damper installation.
- 11. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft using Damper Remover / Replacer Tool T79T-6316-A or equivalent. Install the capscrew and washer. Tighten the screw to 95-122 N·m (70-90 ft-lb). Install the crankshaft pulley.



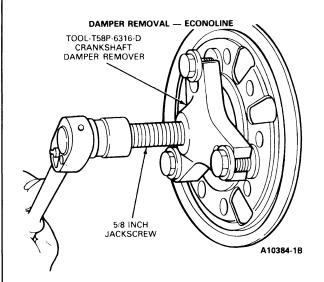
- Complete the remaining steps under Water Pump Installation.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling.
- Operate the engine at fast idle and check the coolant level and check for oil leaks. Check and adjust the ignition timing to specifications on engine decal.
- Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

## E-150 - E-350

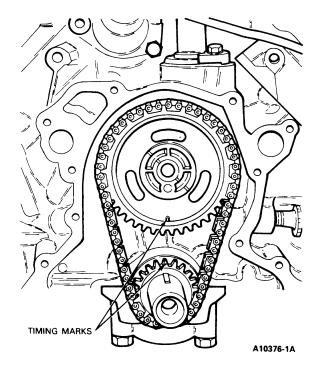
#### Removal

- Drain radiator. Remove radiator. Refer to Section 03-03, Engine Cooling. Remove drive belt.
- 2. Remove upper radiator hose. Remove fan and shroud as an assembly. Raise vehicle on hoist.
- Disconnect radiator lower hose at water pump. Disconnect fuel line at fuel pump and remove pump. Lower vehicle on hoist.
- Remove the A/C compressor/power steering pump bracket and accessories.

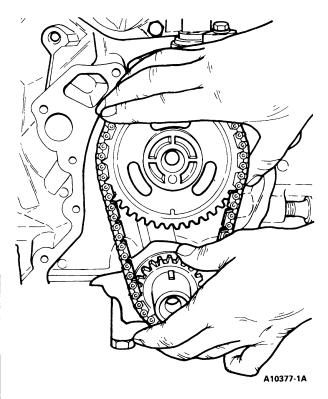
 Remove crankshaft pulley. Remove crankshaft vibration damper using Crankshaft Damper Remover T79T-6316-A. Remove oil pan-to-front cover bolts. Remove front cover and water pump as an assembly.



- 6. Discard the cylinder front cover gasket.
- 7. Check the timing chain deflection. Refer to Section 03-00, Engine—Gasoline—General Service. If deflection exceeds 12.7mm (.500 inches), replace the chain and sprockets.
- Crank the engine until the timing marks on the sprockets are positioned as shown.



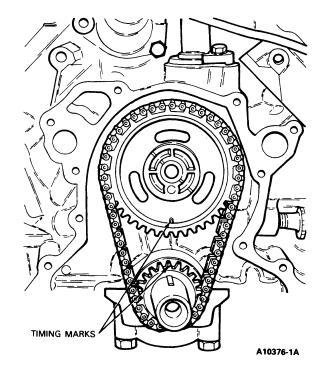
 Remove the camshaft sprocket capscrew, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly.



 Clean front cover, fuel pump and damper. Lubricate seal. Clean gasket surface at pan and trim gasket. Clean front cover gasket surface at block.

#### Installation

 Position the sprockets and timing chain on the camshaft. Be sure the timing marks on the sprockets are positioned as shown.



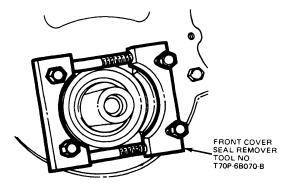
- Install the fuel pump eccentric, washers and camshaft sprocket capscrew. Tighten the sprocket capscrew to 55-61 N·m (40-45 ft-lb).
- Replace oil seal in front cover. Refer to Front Oil Seal. Position gasket to front cover. Apply Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent to oil pan and cylinder block junction. Cut pan gasket, then position to pan and front cover.
  - NOTE: When applying RTV sealant always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.
- Install front cover. Install fuel pump. Install crankshaft vibration damper. Install crankshaft pulley and water pump.
- If so equipped, install power steering pump. Install bypass hose and connect heater hose.
- Install A/C compressor/power steering pump bracket and accessories. Check hoses for condition and correct routing.
- Install radiator upper hose. Raise vehicle on hoist. Connect fuel lines at pump.
- 8. Route the drive belt according to belt routing decal. Drain crankcase. Replace oil filter.

- Lower vehicle on hoist. Install radiator. Refer to Section 03-03, Engine Cooling. Fill crankcase. Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling. Service A/C and power steering systems. Refer to Section 12-03, for A/C service and Section 11-00, for power steering service. Start engine and check for leaks.
- Adjust engine timing to specification on engine decal.

## **Front Oil Seal**

#### Removal

- Remove the bolts attaching the fan shroud to the radiator.
- Remove the fan clutch bolts from the water pump shaft. Remove the fan, clutch and shroud.
- Remove the serpentine drive belt.
- Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper and remove the vibration damper.
- Place the Front Cover Seal Remover T70P-6B070-B or equivalent onto the front cover plate over the front seal as shown. Tighten the two through bolts to force the seal puller under the seal flange.
- Alternately tighten the four puller bolts one-half turn at a time as shown to pull the oil seal from the front cover.

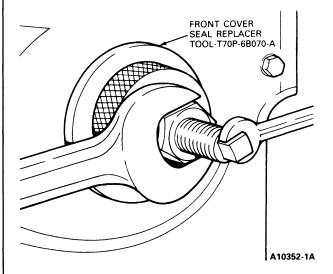


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## Installation

 Coat a new front cover plate oil seal with Lubriplate or equivalent. Place it onto the front oil seal onto Front Cover Seal Replacer T70P-6B070-A or equivalent. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.

 Place the installation screw, washer and nut onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.



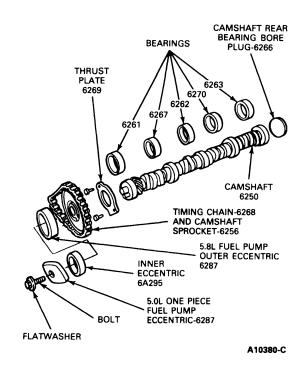
- Apply Lubriplate or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.
- 4. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft. Install the capscrew and washer. Tighten the screw to 95-122 N·m (70-90 ft-lb). Install the crankshaft pulley. Make sure the pulley is bottomed on the damper pilot.
- Position the fan shroud over the water pump pulley. Install the fan and clutch. Install the fan shroud attaching screws.
- Route the drive belt according to the belt routing decal

#### Camshaft

### Removal

- On E-150—E-350 vehicles only, remove the grille.
- Drain the cooling system. Refer to Section 03-03, Engine Cooling. Disconnect the radiator upper and lower hoses. Disconnect the transmission oil cooler lines, if so equipped. Remove the radiator. Refer to Section 03-03, Engine Cooling.
- Remove the A/C and power steering bracket and accessories.
- Remove the cylinder front cover and the timing chain following the procedure under Cylinder Front Cover and Timing Chain Removal.

- Remove the intake manifold throttle body as an assembly following the procedures under Intake Manifold Removal.
- Remove the tappets following the procedure given under Tappet Removal.
- Remove the camshaft thrust plate. Carefully remove the camshaft by pulling toward the front of the engine. Use caution to avoid damaging the camshaft bearings.



## Installation

- Oil the camshaft journals and apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent to the lobes. Carefully slide the camshaft through the bearings. Lubricate the camshaft thrust plate with recommended quality engine oil and install the camshaft thrust plate with the groove toward the cylinder block.
- Lubricate the tappets and tappet bores with heavy engine oil. Install the valve tappets in the bores from which they were removed.
- Lubricate the ends of the push rods with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A), or equivalent and install the push rods in their original positions. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A), or equivalent to the valve stem tips. Lubricate the rocker arms and fulcrum seats with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A), or equivalent and position the rocker arms over the push rods. Tighten bolts to 25-33 N·m (18-25 ft-lb).

- Install the intake manifold and related parts by following the procedure under Intake Manifold Installation.
- Replace the crankshaft front oil seal. Install the timing chain, cylinder front cover and related parts, following the procedure under Cylinder Front Cover and Timing Chain Installation.
- Perform a valve clearance check as outlined.
- Install the valve rocker arm covers following the procedures under Valve Rocker Arm Cover Installation.
- Clean and install the crankcase ventilation system.
- Install the radiator and connect the hoses. Refer to Section 03-03, Engine Cooling. Connect the oil transmission cooler lines, if so equipped.
- Install A/C and power steering bracket and accessories. Refer to Section 13-02, for A/C service and Section 11-00 for power steering service.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase with the proper grade and quality of engine oil.
- Start the engine, then check and adjust the ignition timing (refer to the engine decal for correct settings). Connect the distributor and intake manifold vacuum hoses.
- 13. Operate the engine at fast idle and check all hose connections and gaskets for leaks. Operate the engine until engine temperatures have stabilized, then adjust the engine idle speed and idle fuel mixture (refer to specifications on engine decal). Re-tighten intake manifold bolts and nuts to 32-33 N-m (23-25 ft-lb).
- Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.
- 15. On E-150—E-350 vehicles, install the grille.

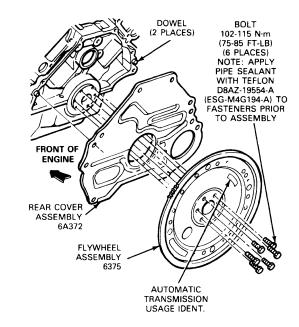
#### **Flywheel**

## Removal

 On a vehicle with a manual transmission, remove the transmission and flywheel housing, clutch pressure plate and disc. Refer to Group 08.

On a vehicle with an automatic transmission, remove the transmission and converter housing. Refer to Group 07.

- To check flywheel face runout or to replace a flywheel ring gear for a manual transmission, refer to Section 03-00, Engine—Gasoline—General Service.
- Remove the flywheel attaching bolts and remove the flywheel.



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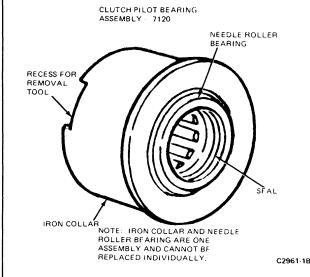
## Installation

- Coat the threads of the flywheel attaching bolts with oil-resistant Threadlock and Sealer EOAZ-19554-AA (ESE-M4G204-A-Type II), or equivalent. Position the flywheel on the crankshaft flange. Install and tighten the bolts in sequence across from each other to 102-115 N·m (75-85 ft-lb).
- On a vehicle with a manual transmission, check the flywheel runout. Refer to Section 03-00, Engine—Gasoline—General Service. Install the clutch pressure plate, disc and the transmission and flywheel housing. Refer to Group 08.

On a vehicle with an automatic transmission, check the flywheel runout. Refer to Section 03-00, Engine—Gasoline—General Service. Install the transmission and converter housing. Refer to Group 07.

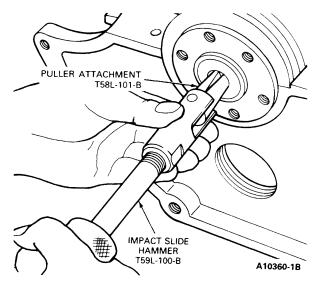
## **Clutch Pilot Bearing**

A needle roller bearing and adapter assembly is used as a clutch pilot bearing on E-150—E-350, F-150—F-350 and Bronco vehicles. It is inserted directly into the engine crankshaft. The bearing and adapter assembly is used with the bearing and adapter comprising an assembly that cannot be serviced separately. The clutch pilot bearing can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.



## Removal

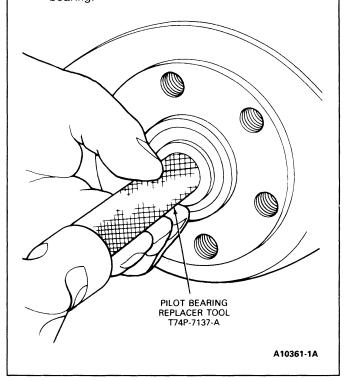
- Remove the transmission and flywheel housing, clutch pressure plate, and disc. Refer to Group 08.
- Using Impact Slide Hammer T59L-100-B and Puller Attachment T58L-101-B or equivalents, remove the pilot bearing.



#### Installation

- Using Pilot Bearing Replacer T74P-7137-A or equivalent, install the pilot bearing with the seal facing the transmission so that the adapter is not cocked.
- Install the clutch pressure plate, disc, and transmission and flywheel housing. Refer to Group 08.

NOTE: Care must be taken not to damage the bearing during transmission installation while the transmission input shaft is being inserted into the bearing.



# Camshaft Rear Bearing Bore Plug Removal

- On a vehicle with a manual transmission, remove the transmission and flywheel housing, clutch pressure plate and disc. Refer to Group 08.
  - On a vehicle with an automatic transmission, remove the transmission and converter housing. Refer to Group 07.
- Remove the flywheel attaching bolts and remove the flywheel. Remove the engine rear cover plate.
- Replace the rear bearing bore plug. Refer to Section 03-00, Engine—Gasoline—General Service.

#### Installation

- Coat the flywheel attaching bolts with oil-resistant Threadlock and Sealer EOAZ-19554-AA (ESE-M4G204-A-Type II), or equivalent. Position the engine rear cover plate on the cylinder block dowels. Position the flywheel on the crankshaft flange. Install and tighten the attaching bolts in sequence, across from each other to 102-115 N·m (75-85 ft-lb).
- On a vehicle with a manual transmission, install the clutch pressure plate, disc and the transmission and flywheel housing. Refer to Group 08.
- 3. On a vehicle with an automatic transmission, install the transmission and converter housing. Refer to Group 07.

## **Crankshaft Rear Oil Seal**

For replacement of a crankshaft rear oil seal refer to Crankshaft Rear Oil Seal Replacement in Section 03-00, Engine—Gasoline—General Service.

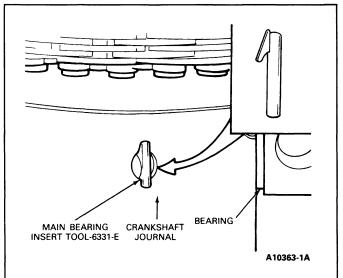
## **Main Bearing**

The main bearing inserts are selective fit. Refer to the procedures under Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.

#### Engine dasonne denerares

#### Removal

- Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts following the procedure under Oil Pan Removal.
- 2. Remove the oil pump inlet tube assembly and the oil pump.
- Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.
- Insert Upper Main Bearing Insert Remover and Replacer TOOL-6331-E or equivalent in the oil hole in the crankshaft.
- Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
- Clean each crankshaft journal. Inspect the journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear.
- 7. If the rear main bearing is being replaced, remove and discard the rear oil seal from the bearing cap.
- 8. Remove the block half of the rear oil seal following the procedures under Crankshaft Rear Oil Seal Removal, Section 03-00, Engine—Gasoline—General Service.

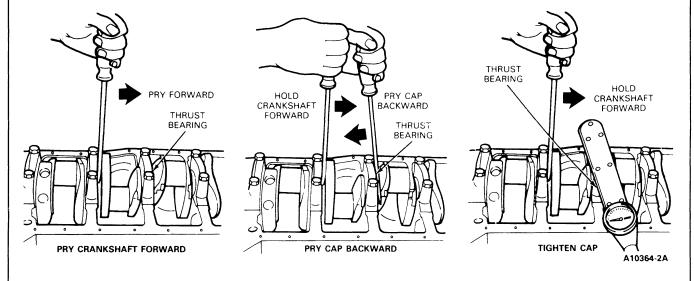


#### Installation

- If the rear main bearing is being replaced, clean the rear oil seal groove in the block with a brush and solvent.
- Install the block half of the rear oil seal following the procedures under Crankshaft Rear Oil Seal Installation, Section 03-00, Engine—Gasoline—General Service.
- 3. To install an upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that Upper Main Bearing Insert Remover and Replacer TOOL-6331-E or equivalent can be inserted in the oil hole in the crankshaft. With Upper Main Bearing Insert Remover and Replacer TOOL-6331-E or equivalent in the hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.
- 4. Install the bearing cap.
- Select fit the bearing for proper clearance following the procedures under Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.
- 6. If the bearing is being replaced on journal number 1, 2 or 4, apply a coat of engine oil of the quality recommended in the Owner's Manual to the journal and bearings and install the bearing cap. Tighten the cap bolts. On 5.0L (302 CID) V-8 tighten cap bolts to 82-94 N·m (60-70 ft-lb); on 5.8L EFI (351 CID) W-V-8 tighten to 129-142 N·m (95-105 ft-lb).
- Clean the oil seal groove with a brush and solvent.
- 8. Install the lower seal in the rear main bearing cap with the undercut side of the seal toward the FRONT of the engine. Allow the seal to protrude approximately 9.53mm (3/8 inch) above the parting surface to mate with the upper seal when the cap is installed.

- Refer to Section 03-00, Engine—Gasoline—General Service for instructions in applying RTV sealer to the rear main bearing cap. Lubricate the journal with engine oil of the quality recommended in the Owner's Manual and install the rear main bearing cap. Tighten the cap bolts on 5.0L EFI (302 CID) V-8 to 82-94 N·m (60-70 ft-lb); on 5.8L EFI (351 CID) W-V-8 to 129-142 N·m (95-105 ft-lb).
- If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Lubricate the journal with engine oil of the quality recommended in the Owner's Manual and install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Tighten the cap bolts on 5.0L EFI (302 CID) V-8 to 82-94 N·m (60-70 ft-lb); on 5.8L EFI (351 CID) W-V-8 to 129-142 N·m (95-105 ft-lb).



- 11. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.
- Position the oil pan gaskets on the oil pan. Install the oil pan and related parts following the procedure under Oil Pan Installation. Install the oil level dipstick.
- Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

## **Connecting Rod Bearings**

The connecting rod bearings are selective fit. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.

#### Removal

- Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal.
- Remove the oil pump inlet tube assembly and the oil pump.
- Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down.
  - Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.

## Installation

- Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.
- Clean the crankshaft journal.
- Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.
- Pull the connecting rod assembly down firmly on the crankshaft journal.
- Select fit the bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.
- After the bearing has been fitted, clean and apply a coat of engine oil of the quality recommended in the Owner's Manual to the journal and bearings. Install the connecting rod cap. Tighten the nuts on 5.0L EFI (302 CID) V-8 to 26-32 N·m (19-24 ft-lb); on 5.8L EFI (351 CID) W-V-8 to 55-61 N·m (40-45 ft-lb).
- Repeat the procedure for the remaining connecting rods that require new bearings.

- Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.
- 9. Position the oil pan gaskets on the cylinder block. Position the oil pan front seal on the cylinder block front cover and interlock the seal with the gaskets. Position the oil pan rear seal on the rear main bearing cap and interlock the seal with the gaskets. Install the oil pan and related parts following the procedure under Oil Pan Installation. Install the oil level dipstick.
- Fill the crankcase with engine oil of the quality and quantity recommended in the Owner's Manual. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

## **Pistons and Connecting Rods**

### Removal

- Drain the cooling system. Refer to Section 03-03, Engine Cooling. Drain the crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump as outlined.
- Remove any ridges and / or deposits from the upper end of the cylinder bores as follows.

Turn the crankshaft until the piston to be removed is at the bottom of its travel, then place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturers. Never cut into the ring travel area in excess of 0.794 mm (1/32 inch) when removing ridges.

- Ensure all connecting rod caps are marked so that they can be installed in their original positions.
- Turn the crankshaft until the connecting rod being removed is down.
- 5. Remove the connecting rod nuts and cap.
- Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.
- 7. Remove the bearing inserts from the connecting rod and caps.
- Install the cap on the connecting rod from which it was removed.

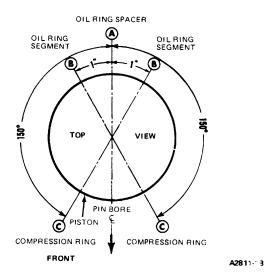
#### Installation

 If new piston rings are to be installed, remove the cylinder wall glaze. Follow the instructions of the tool manufacturer. The small depression on the ring designates the top.

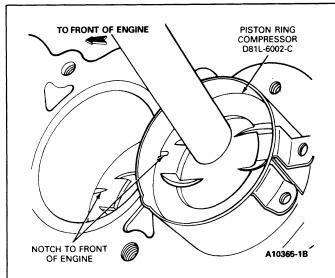
- Install rings using a piston ring installation tool of the proper size.
- 3. Oil the piston rings, pistons and cylinder walls with recommended quality engine oil. Be sure to install the pistons in the same cylinders from which they were fitted. The connecting rod and bearing caps are numbered from 1 to 4 in the RH bank and from 5 to 8 in the LH bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

When installing the piston and connecting rod assembly, the largest chamfer at the bearing end of the rod should be positioned toward the crank pin thrust face of the crankshaft.

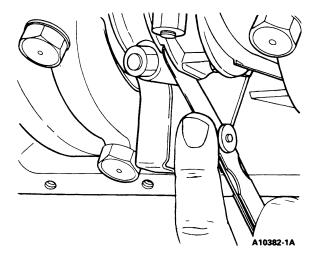
 Ensure the ring gaps (oil ring spacer-A, oil ring-B, compression ring-C) are properly spaced around the circumference of the piston.



5. Install Piston Ring Compressor D81L-6002-C or equivalent on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder. Be sure to guide the connecting rods to avoid damaging the crankshaft journals. Install the piston with the indentation notch in the piston head toward the front of the engine.



- Check the clearance of each bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.
- After the bearings have been fitted, apply a light coat of recommended engine oil to the journals and bearings.
- Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
- Install the connecting rod cap. Tighten the nuts on 5.0L EFI (302 CID) V-8 to 26-32 N·m (19-24 ft-lb); on 5.8L EFI (351 CID) W-V-8 to 55-61 N·m (40-45 ft-lb).
- After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each shaft journal.



 Disassemble, clean, and assemble the oil pump. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.

- 12. Prime the oil pump by filling the inlet port with engine oil of the quality recommended in the Owner's Manual and rotating the pump shaft to distribute the oil within the housing. Install the oil pump and the oil pan following the procedures under Oil Pan Installation.
- Install the cylinder heads following the steps under Cylinder Head Installation.
- Install the intake manifold following the steps under Intake Manifold Installation.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase with the proper quality and quantity of engine oil as recommended in the Owner's Manual.
- Start the engine, then check and adjust the ignition timing. Connect the distributor vacuum hoses to the distributor.
- 17. Operate the engine at fast idle and check for oil and coolant leaks. Operate the engine until engine temperatures have stabilized, then adjust the engine idle speed and idle fuel mixture to specifications on engine decal.
- 18. Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

#### Oil Filter

#### Removal

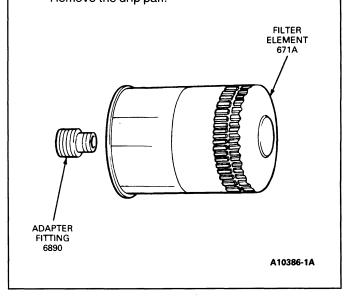
- 1. Position a drip pan under the oil filter.
- Unscrew the filter from the adapter fitting using an Oil Filter Wrench D79L-6731-A or B or equivalent and clean the adapter fitting.

On E-150—E-350 equipped with power steering, ensure the wheels are fully to the right before removing the filter. Then, unscrew the filter from the adapter fitting, turn it horizontal and let the excess oil drain off. Slide the oil filter toward the rear of the vehicle and remove. Some effort may be required to slide the oil filter between the engine crossmember and power steering hoses.

#### Installation

- Coat the gasket on a new filter with recommended quality engine oil. Place the new filter in position on the adapter fitting.
  - On E-150—E-350 equipped with power steering, make sure that the wheels are turned fully to the right, then slide the oil filter forward between the crossmember and power steering hoses to position it on the adapter fitting.
- 2. Hand-tighten the filter until the gasket makes contact and then advance it one-half turn.
- Check the oil level and fill the crankcase with engine oil of the quality recommended in the Owner's Manual as necessary.

 Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Remove the drip pan.



#### REMOVAL AND INSTALLATION

## **Engine Assembly**

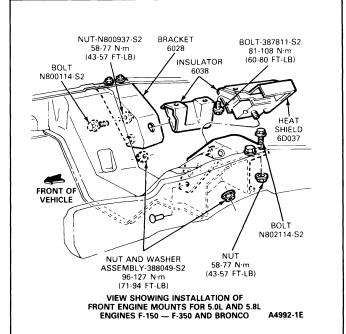
The engine removal and installation procedures are for the engine only without the transmission attached.

## F-150-F-250-Bronco

#### Removal

- Drain the cooling system and the crankcase. Refer to Section 03-03, Engine Cooling. Remove hood. Refer to Section 01-02, Body Panels, Front End.
- Disconnect the battery and ground cables from the cylinder block.
- On 5.8L EFI remove the air intake duct assembly, including the crankcase ventilation hose and carbon canister hose. On 5.0L EFI remove the air intake hoses, PCV tube, and carbon canister hose.
- Disconnect the radiator lower and upper hose at the radiator. If equipped with an automatic transmission, disconnect the transmission oil cooler lines.
- Disconnect and cap-off the power steering hoses.
- 6. Disconnect the thermactor air pump hoses.
- If so equipped, discharge the A/C system and remove the A/C condenser. Refer to Section 12-03A, A/C-Heater System, F-Series and Bronco. Disconnect A/C lines at the compressor. Disconnect the A/C compressor clutch wire.

- 8. Remove the fan shroud and position it over the fan. Remove the radiator. Refer to Section 03-03, Engine Cooling. Relieve the belt tension and remove the belt.
- Disconnect the alternator wires.
- Remove the brackets for the air pump, alternator, power steering and compressor. Disconnect the power steering pump lines.
- 11. Disconnect the oil pressure sending unit wire from the sending unit, and the flexible fuel line at the fuel tank line. Plug the fuel tank line. Disconnect evaporative emission hoses at the evaporative canister. For 5.0L EFI, disconnect chassis fuel line guick disconnects at fuel rails.
- 12. Disconnect the accelerator cable from the throttle body. Disconnect speed control linkages, if so equipped. Disconnect the transmission kickdown rod and remove the retracting spring, if so equipped. Disconnect power brake booster vacuum hose, if so equipped. For 5.0L EFI, after disconnecting accelerator and transmission T.V. cable from throttle body, disconnect throttle bracket from upper intake manifold and swing out of the way with cables still attached to bracket.
- Disconnect the heater hoses from the water pump and intake manifold, or at tee for 5.0L EFI. Disconnect the water temperature sending unit wire from the sending unit.
- Remove the flywheel housing-to-engine upper bolts.
- Disconnect the engine wire loom and position out of the way. Disconnect the ground strap from the cylinder block.
- Raise the front of the vehicle. Disconnect the starter cable from the starter. Remove the starter. Refer to Section 03-06A, Starter—Positive Engagement.
- 17. Disconnect the muffler inlet pipes and exhaust heat control valve, if so equipped, from the exhaust manifolds. Disconnect the engine support insulators from the brackets on the frame underbody.



- On a vehicle with automatic transmission, remove the converter inspection plate. Remove the torque converter-to-flywheel attaching bolts.
- Remove the remaining flywheel housing-to-engine bolts.
- Lower the vehicle, and support the transmission. Install Engine Lifting Bracket Tool T70P-6000 or equivalent on the intake manifold lifting eyes (5.8L-W EFI). Then, attach the engine lifting sling (attach to engine mounted lifting eyes for 5.0L EFI).
- 21. Raise the engine slightly and carefully pull it from the transmission. Carefully lift the engine out of the engine compartment so that the rear cover plate is not bent or other components damaged. Install the engine on a workstand.

#### Installation

- Attach the engine lifting brackets and sling. Remove the engine from the workstand.
- Lower the engine carefully into the engine compartment. Make sure the dowels in the block are through the rear cover plate, then engage the holes in the flywheel housing.

On a vehicle with manual transmission, start the transmission main driveshaft into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.

Install the flywheel housing upper bolts.

- Install the engine support insulator-to-bracket washers and attaching nuts. Disconnect the engine lifting sling and remove the lifting eyes (5.8L-W EFI). 5.0L EFI lifting eyes remain with engine.
- Raise the front of the vehicle. Connect both exhaust manifolds and exhaust heat control valve, if so equipped, to the muffler inlet pipes. Tighten the nuts to specifications. Refer to Section 09-00, Exhaust System.
- Position and install the starter and the starter cable. Refer to Section 03-06A, Starter—Positive Engagement.
- Install the remaining flywheel housing-to-engine bolts.
- 8. On a vehicle with automatic transmission, install the converter-to-flywheel attaching bolts. Install the converter inspection plate.
- 9. Remove the support from the transmission and lower the vehicle.
- Install the A / C and power steering bracket and components.
- 11. Install the alternator / air pump bracket.
- If so equipped, connect the A/C compressor magnetic clutch lead wire. Refer to Section 12-03A, A/C-Heater System, F-Series and Bronco.
- 13. Connect the engine wire loom.
- 14. Connect the water temperature sending unit wire.
- 15. Connect the bellcrank/linkage bracket to the intake manifold. Connect the transmission shift rod or cable, if so equipped, as outlined. Install the retracting spring. Connect the accelerator rod and speed control linkage, if so equipped.
- 16. Remove the plug from the fuel tank line and connect the fuel line and the oil pressure sending unit wire. Reconnect evaporative emission hoses at the evaporative canister. For 5.0L EFI, reconnect chassis fuel lines to fuel rails.
- Install the pulley, clutch and fan. Position the fan shroud over the fan. Install the belt according to the belt routing decal. Tension belt to specifications.
- Position the alternator and install the alternator bolts. Connect the battery ground cable. Adjust the belt tension to specification. Refer to Section 03-05, Engine—Accessory Drive.
- If so equipped, connect two A/C lines to the A/C compressor. Refer to Section 12-03A, A/C-Heater System. F-Series and Bronco.
- Install the radiator. Refer to Section 03-03, Engine Cooling. Connect the radiator upper and lower hoses. Connect the transmission oil cooler lines, if so equipped. Install the fan shroud.

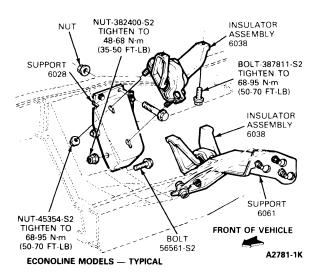
- If so equipped, install the A/C condenser to the radiator. Refer to Section 12-03A, A/C-Heater System, F-Series and Bronco.
- 22. Connect the heater hoses at the water pump and intake manifold. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase with the proper grade and quantity of oil. Connect the power brake booster vacuum hose, if so equipped.
- 23. Operate the engine at fast idle and check all gaskets and hose connections for leaks. Purge the power steering system of any air as outlined in Section 11-00, Steering General Service.
- Install the air cleaner and intake duct assembly including the crankcase ventilation hose and carbon canister hose.
- Evacuate and charge the A/C system, if so equipped. Refer to Section 12-03, Air Conditioning—General Service.
- 26. Install hood. Refer to Section 01-02, Body Panels, Front End.

#### E-150-E-350

#### Removal

- Remove engine cover, open the hood, disconnect battery and drain cooling system. Refer to Section 03-03, Engine Cooling. Remove grille assembly including gravel deflector. Remove air cleaner, air ducts and closure hose (5.0L).
- Remove the upper grille support bracket, hood lock support and condenser upper mounting brackets, if so equipped.
- If so equipped, discharge the A/C system, and remove the A/C condenser. Refer to Section 12-03B, A/C-Heater System, Econoline. Disconnect the A/C lines at the compressor, and remove the accelerator cable bracket. Disconnect the speed control linkage, if so equipped. Disconnect the two heater hoses from the engine.
- Disconnect the radiator hoses at the radiator. Disconnect the heater hoses at the heater core and the water valve.
- If equipped with an automatic transmission, disconnect the oil cooler lines at the radiator.
- Remove the fan shroud and fan assembly.
   Remove the radiator from the vehicle. Refer to
   Section 03-03, Engine Cooling. Remove water
   pump pulley. Disconnect the alternator lead wires
   at the alternator.
- 7. Release belt tension and remove the belt.
- 8. Disconnect the power steering, thermactor air pump, alternator and A/C compressor. Plug hoses as necessary. Disconnect the wire from the A/C compressor clutch.
- Remove the accessory brackets complete with accessories.

- 10. Remove the air cleaner assembly.
- Disconnect the throttle linkage at the throttle body and remove the accelerator cable bracket from the engine. Disconnect the transmission shift rod, if so equipped.
- Raise the vehicle on a hoist, drain the crankcase and remove the oil filter.
- 13. Disconnect the muffler inlet pipes and exhaust heat control valve, if so equipped, at the exhaust manifolds. Remove two bolts retaining the transmission filler tube bracket to the RH cylinder head.
- 14. Remove the engine mount attaching bolts and nuts. Remove the starter motor and disconnect the cable. On vehicles equipped with a manual transmission, remove the housing-to-engine bolts. On vehicles equipped with an automatic transmission, remove the converter inspection cover bolts.



- Remove four nuts attaching the converter to the flex plate.
- Remove three bolts retaining the adapter plate to the converter housing.
- Remove four converter housing-to-cylinder block lower bolts. Remove the bolt retaining the ground cable to the cylinder block. Lower the vehicle and support the transmission.
- Disconnect the engine wire loom and position it out of the way.
- Engine Lifting Plate Tool T75T-6000-A or equivalent to the intake manifold (attaching bolts). Remove two converter housing-to-cylinder block upper bolts.

- 20. Position a floor jack under the transmission for support. Position a floor crane to the vehicle and connect it to the lifting bracket. Use engine mounted lifting eyes. Carefully move engine forward in the engine compartment so that no components are damaged.
- 21. Remove the engine from the vehicle.
- 22. Install engine on a workstand.

#### Installation

 On vehicles equipped with an automatic transmission, connect the floor crane to the engine. Raise the engine and position it into the vehicle aligning the transmission converter to the flywheel (or flex plate) and the engine dowels to the transmission. Lower the engine to the chassis brackets, and align the through-bolt holes on the engine supports.

On vehicles equipped with a manual transmission, start the transmission main clutch driveshaft into the clutch disc.

It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.

Align the housing on the engine and insert the housing-to-engine bolts. Tighten bolts to 55-67 N-m (40-50 ft-lb).

- On vehicles equipped with an automatic transmission, install two converter housing-to-cylinder block lower bolts. Remove the lifting bracket from the intake manifold.
- 3. Remove floor jack from under the transmission, and position it out of the way.
- 4. Install brackets and accessories.
- If so equipped, connect the A/C compressor magnetic clutch lead wire. Refer to Section 12-03B, A/C-Heater System, Econoline.
- Position the accelerator cable mounting bracket and install three attaching bolts.
- Position the engine wire harness in retainers and connect at respective locations. Connect vacuum lines at the center of the upper intake manifold. Connect the power brake booster vacuum hose, if so equipped.
- 8. Connect two heater hoses: one at the heater core and one at the water valve. Connect the A/C compressor, thermactor air pump, alternator and power steering pump.
- Install the water pump pulley, clutch and fan to the water pump and position the shroud over the fan assembly.

- 10. Raise the vehicle on a hoist. Install one bolt attaching ground cable to cylinder block (on vehicles equipped with an automatic transmission, four lower converter housing-to-cylinder block bolts). Install the three adapter plate-to-converter housing bolts. Install four nuts retaining the converter to the flex plate. Install the converter inspection cover and retaining bolts. On vehicles equipped with a manual transmission, start the transmission main driveshaft into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.
- Install the starter motor and connect the cable. Install the engine mount attaching bolts and nuts. Tighten to 68-95 N·m (50-70 ft-lb).
- 12. Install the two bolts that retain the transmission filler tube bracket to the RH cylinder head.
- Connect the muffler inlet pipes and exhaust heat control valve, if so equipped, at the exhaust manifolds. Refer to Torque Specifications in Section 09-00, Exhaust System General Service. Install the oil filter.
- 14. Connect the throttle and transmission linkage and the speed control linkage, if so equipped, at the throttle body. Connect the alternator lead wires to the alternator.
- 15. Lift belt tensioner and route the belt over all the pulleys according to the belt routing decal. Refer to Section 03-05, Engine—Accessory Drive. Tighten adjusting bolt to 33-54 N·m (20-40 ft-lb), and the pivot bolt to 55-67 N·m (40-50 ft-lb). If so equipped, connect two A/C lines at the A/C compressor. Refer to Section 12-03B, A/C-Heater System, Econoline. Install the accelerator cable bracket to the dash.
- 16. Position the radiator the the radiator support and secure with four attaching bolts. Refer to Section 03-03, Engine Cooling. Install the shroud and secure with four attaching bolts.
- Connect two oil cooler lines at the radiator, if so equipped.
- 18. Connect the radiator hoses at the radiator.
- Install the A/C condenser to radiator support, if so equipped. Refer to Section 12-03B, A/C-Heater System, Econoline. Install the grille upper support bracket, hood lock support and condenser upper mounting brackets.
- Install the grille assembly. Fill the crankcase. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Install air cleaner, air ducts and closure hose (5.0L).

- Connect battery, start engine and check for leaks. Adjust idle speed to specifications on engine decal.
- Evacuate and charge the A/C system, if so equipped. Refer to Section 12-03, Air Conditioning—General Service. Install the air cleaner assembly.
- 23. Install the engine cover.

## Crankshaft

#### Removal

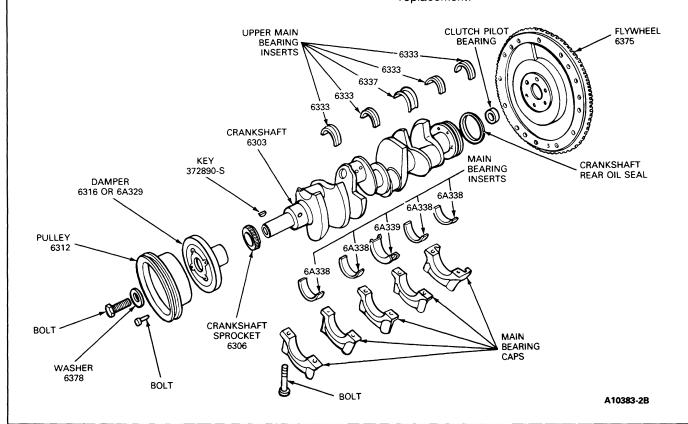
- With the engine removed from the vehicle and placed in a workstand, disconnect the spark plug wires at the spark plugs and remove the wires and bracket assembly from the attaching stud on the valve rocker arm covers using Spark Plug Wire Remover T75P-6666-A or equivalent. Disconnect the coil to distributor high-tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly. Remove the spark plugs to allow easy rotation of the crankshaft.
- Remove the oil filter. Slide the water pump bypass hose clamp toward the water pump. Remove the alternator and mounting brackets.
- Remove the crankshaft pulley from the crankshaft vibration damper. Remove the capscrew and washer from the end of the crankshaft. Install the puller using Crankshaft Damper Remover T58P-6316-D or equivalent on the crankshaft vibration damper and remove the damper.
- 4. Remove the cylinder front cover and water pump as an assembly.
- Check the timing chain deflection. Refer to Section 03-00, Engine—Gasoline—General Service. Then, remove the timing chain and sprockets by following procedure under Cylinder Front Cover and Timing Chain Removal.
- Invert the engine on the workstand. Remove the clutch pressure plate and disc (manual-shift transmission). Remove the flywheel and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.
- 7. Ensure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is down, and remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all the connecting rod bearing caps are removed.
- 8. Remove the main bearing caps.

- Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.
- 10. Remove rear journal oil seal from the block and rear main bearing cap.
- Remove the main bearing inserts from the block and bearing caps.
- 12. Remove the connecting rod bearing inserts from the connecting rods and caps.

To refinish journals and dress minor imperfections, refer to Section 03-00, Engine—Gasoline—General Service.

#### Installation

- If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.
- Place the upper main bearing inserts in position in bores with the tang fitting in the slot provided.
- Install the lower main bearing inserts in the bearing caps.
- Clean the rear journal oil seal groove and the mating surfaces of the block and rear main bearing cap with Ford Spot Remover B7A-19521-AA (ESR-M5B197-A), or equivalent. Refer to Section 03-00, Engine—Gasoline—General Service for seal replacement.



- 5. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.
- Check the clearance of each main bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.
- After the bearings have been fitted, refer to Section 03-00 for special instructions in applying Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent to the rear main bearing cap.
- Apply engine oil of the quality recommended in the Owner's Manual to the journals and bearings.
- Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). Be sure that the main bearing caps are installed in their original locations. Tighten the bearing cap bolts on 5.0L EFI (302 CID) V-8 to 82-94 N·m (60-70 ft-lb); on 5.8L EFI (351 CID) W-V-8 to 129-142 N·m (95-105 ft-lb).
- Install the thrust bearing cap with the bolts finger-tight.

- 11. Pry the crankshaft forward against the thrust surface on the upper half of the bearing.
- 12. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.
- Retain the forward pressure on the crankshaft. Tighten the cap bolts on 5.0L EFI (302 CID) V-8 to 82-94 N·m (60-70 ft-lb); on 5.8L EFI (351 CID) W-V-8 to 129-142 N·m (95-105 ft-lb).
- 14. Force the crankshaft toward the rear of the engine.
- Check the crankshaft end play. Refer to Section 03-00, Engine—Gasoline—General Service.
- Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.
- After the connecting rod bearings have been fitted, apply a light coat of recommended quality engine oil to the journals and bearings.
- 18. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.
- Install the connecting rod cap. Tighten the nuts on 5.0L EFI (302 CID) V-8 to 26-32 N·m (19-24 ft-lb); on 5.8L EFI (351 CID) W-V-8 to 55-61 N·m (40-45 ft-lb).
- 20. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each connecting rod crankshaft journal. Refer to Specifications.
- 21. Install the timing chain the sprockets, cylinder front cover and crankshaft pulley and adapter following Cylinder Front Cover and Timing Chain Installation procedure.
- 22. Coat the threads of the flywheel attaching bolts with oil-resistant Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A-Type II), or equivalent. Position the flywheel on the crankshaft flange. Install and tighten the bolts to 102-115 N-m (75-85 ft-lb).

On a flywheel for manual-shift transmission, use Clutch Housing Alignment Tool T75L-6392-A or equivalent to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts to 102-115 N·m (75-85 ft-lb).

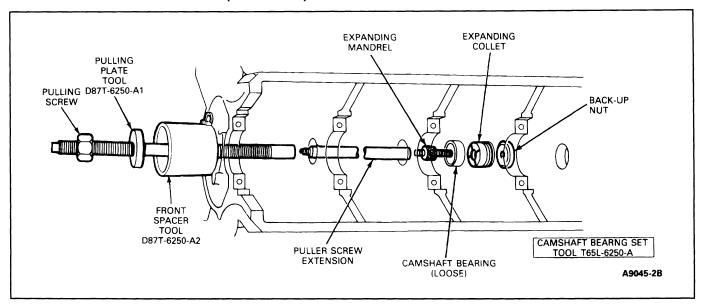
- 23. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and oil pan by following the procedures under Oil Pan and Oil Pump Installation.
- Install the oil filter, fuel pump and connect the fuel lines. Install the alternator, shield and mounting bracket.
- Install the spark plugs, distributor cap and spark plug wires. Connect the spark plug wires and high-tension lead.
- 26. Install the engine in the vehicle.

## **Camshaft Bearings**

Camshaft bearings are available prefinished to size for standard and 0.38mm (0.015 inch) undersize journal diameters. The bearings are not interchangeable from one bore to another.

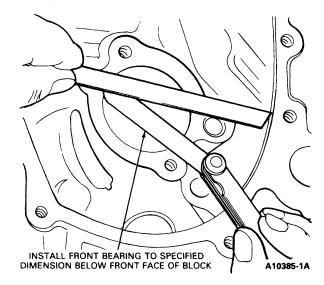
#### Removal

- Remove the camshaft, flywheel and crankshaft as outlined. Push the pistons to the top of the cylinders.
- Select the proper size expanding collet and backup nut and assemble on the expanding mandrel Camshaft Bearing Set T65L-6520-A or equivalent.
  - With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the backup nut on the expanding mandrel until the collet fits the camshaft bearing.
- Assemble the puller screw and extension (if necessary) and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.
- 4. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.



#### Installation

Position the new bearing at the bearing bores with the oil holes aligned and press them in place with the Camshaft Bearing Set T65L-6250-A or equivalent. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. Failure to use the correct expanding collet can cause severe bearing damage. Ensure the front bearing is installed 0.127-0.508mm (0.005-0.020 inches) below the front face of the cylinder block.



Install a new rear bearing bore plug.

 Install the camshaft, crankshaft, flywheel and related parts as outlined. Do not check connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement. Install the engine in the vehicle.

#### **DISASSEMBLY AND ASSEMBLY**

When installing nuts or bolts that must be tightened (refer to specifications), oil the threads with lightweight engine oil. Do not oil threads that require oil-resistant or water-resistant sealer.

Refer to Section 03-00, Engine—Gasoline—General Service for the cleaning and inspection procedures.

## **Engine**

## Disassembly

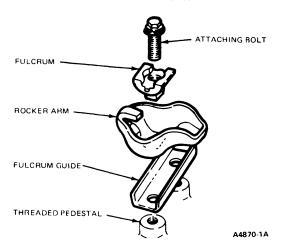
NOTE: Before starting disassembly, remove all wiring harnesses, emission control system, fuel system, ignition system, flywheel, rear cover plate and front end accessory drive components.

For more detailed information on a particular system, refer to the specific section in the appropriate repair group.

With the engine mounted on a workstand:

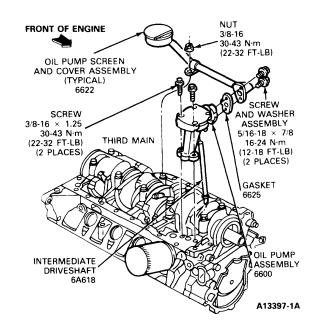
- Remove the left and right hand rocker arm covers and discard the gaskets.
- 2. Remove the upper and lower intake manifold assemblies as detailed in this section.
- Remove the oil dipstick and tube assembly and remove the oil filter.

 Remove the valve rocker arms, fulcrums, push rods, guides and tappets and remove the cylinder heads as detailed in this section.



NOTE: All valve train components should be identified to ensure they are installed in their original positions during assembly.

- Remove the crankshaft pulley and damper as detailed in this section.
- Remove the water pump and front cover as an assembly. Discard the gasket and seal.
- 7. Remove the oil pan and discard the gasket.
- Remove the oil pump, pickup tube and intermediate driveshaft.

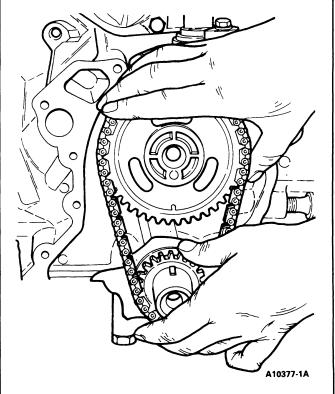


Remove the rear crankshaft seal.

- Remove the camshaft sprocket, capscrew, washer and eccentric. Slide the sprocket and timing chain forward and remove the chain and sprocket as an assembly.
- Remove the camshaft thrust plate and remove the camshaft.

NOTE: Pistons, connecting rods and bearings should be numbered to ensure they are assembled in their original positions.

NOTE: Before removing pistons, inspect the top of the cylinder bores. If necessary, remove the ridge and/or carbon deposits from each cylinder using Cylinder Ridge Reamer T64L-6011-EA, or equivalent as outlined in Section 03-00, Engine—Gasoline—General Service.

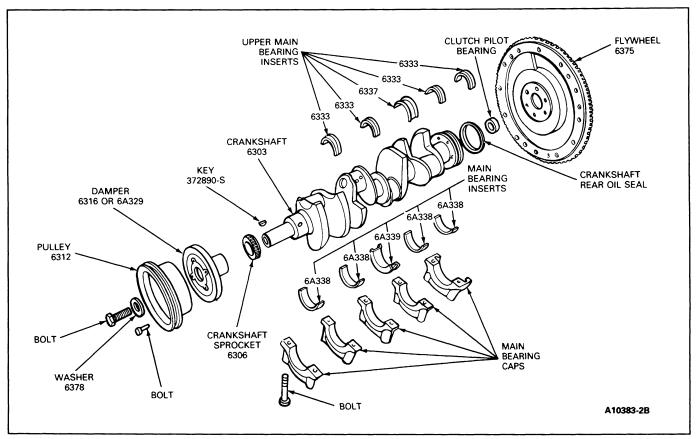


- Remove the connecting rod caps and remove the pistons.
- Remove the crankshaft main bearing caps, bearings and crankshaft.

CAUTION: When removing the crankshaft, take care not to damage any of the bearing surfaces on the crankshaft.

NOTE: The location of the main bearing caps and the main bearing inserts should be identified. When the engine is assembled, bearings which are to be reused should be installed in their original positions.

14. For cleaning purposes, the oil gallery and coolant drain plugs can be removed.



#### **Assembly**

Before assembling cylinder block, all sealing surfaces must be clean and free of chips, dirt, paint, and foreign material. Also ensure coolant and oil passages are clear.

If new piston rings are to be installed and no visible cross hatch marks remain on the cylinder wall, remove cylinder wall glaze using a spring type tool. Follow instructions of tool manufacturer.

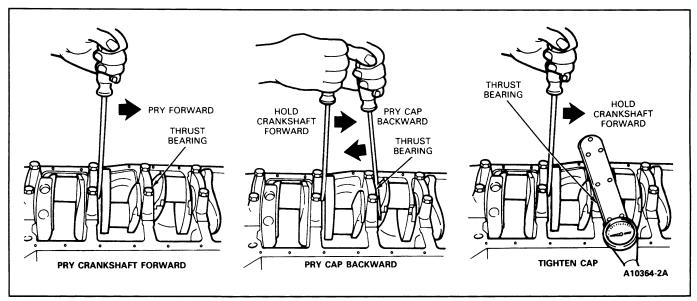
NOTE: Lightly oil all attaching bolt and stud threads before installation, except those specifying special sealant.

- Place crankshaft upper main bearings in position in the bores with the tang fitting in the slot provided. Lubricate bearings with SAE 50 weight, ESE-M2C39-F or equivalent oil.
- Install the lower main bearings in the bearing caps.
- Carefully lower crankshaft into place. Use care to prevent damage to bearing surfaces.

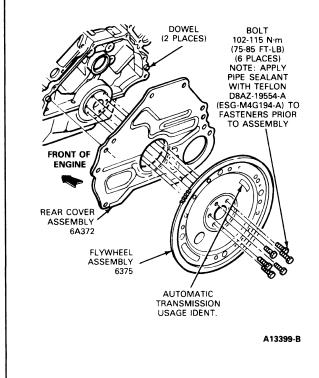
- 4. Check clearance of each main bearing, following the procedure under Fitting Main and Connecting Rod Bearings in Section 03-00, Engine—Gasoline—General Service.
- 5. After bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
- Install all bearings and caps except thrust bearing cap (No. 3 bearing). ENSURE MAIN BEARING CAPS ARE INSTALLED IN THEIR ORIGINAL POSITION. Tighten bearing caps to specification.

NOTE: Apply sealer D6AZ-19562-B in a 1.59mm (1/16 inch) bead in each corner of rear main bearing cap saddle, the full length of the saddle.

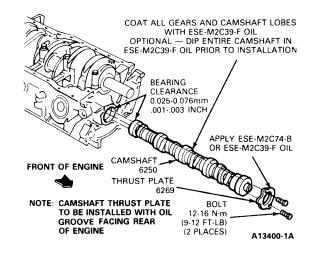
- Install thrust bearing cap (No. 3) with bolts finger tight.
- 8. Pry crankshaft forward against thrust surface of upper half of bearing.
- Hold crankshaft forward and pry thrust bearing cap to the rear. This will align thrust surfaces of both halves of the bearing.
- 10. Retain forward pressure on crankshaft. Tighten cap bolts to specification.



- 11. Force crankshaft toward the rear of the engine.
- 12. Check crankshaft end play. Refer to Section 03-00, Engine—Gasoline—General Service.
- Install crankshaft rear oil seal. Refer to Section 03-00, Engine—Gasoline—General Service. Install rear cover plate and flywheel and torque bolts to specification.

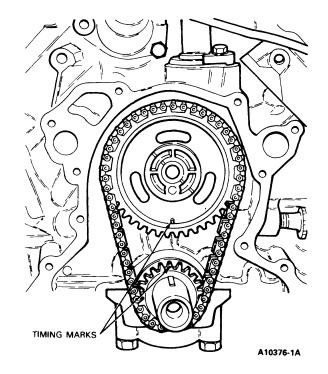


- 14. Coat all camshaft bearings, camshaft lobes and gear with engine oil.
- Carefully slide camshaft through camshaft bearings. Install camshaft thrust plate with groove toward cylinder block. Tighten thrust plate retaining bolts.

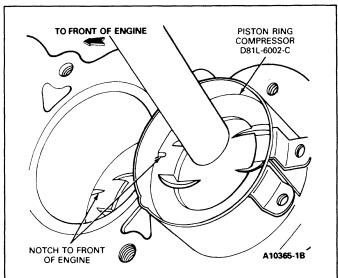


 Check camshaft end play. Refer to Section 03-00, Engine—Gasoline—General Service. If not within specification, replace thrust plate.

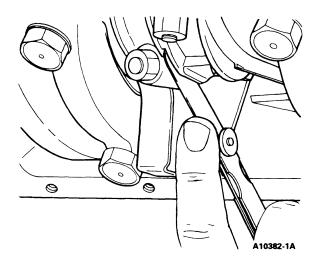
17. Install camshaft sprocket, timing chain and eccentric. Position sprocket and timing chain on camshaft and crankshaft sprocket simultaneously. Ensure timing marks on the sprockets are aligned.



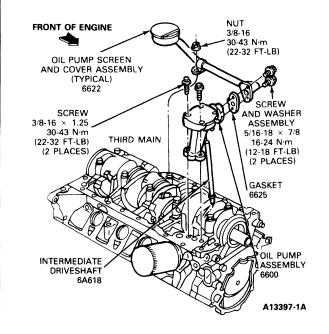
- Install eccentric, washers, and camshaft capscrew. Tighten camshaft capscrew to specification.
- Oil the piston rings, pistons and cylinder walls. Be sure to install the pistons in the same cylinders from which they were removed.
- Ensure the ring gaps are properly spaced around the circumference of the piston. (Refer to Piston and Connecting Rod Installation in this section.)
- 21. Install a piston ring compressor on the piston and push piston in with a hammer handle until it is slightly below top of cylinder. Be sure to guide connecting rods to avoid damaging crankshaft journals (cover studs). INSTALL PISTON WITH INDENTATION NOTCH IN THE PISTON HEAD TOWARD FRONT OF ENGINE.



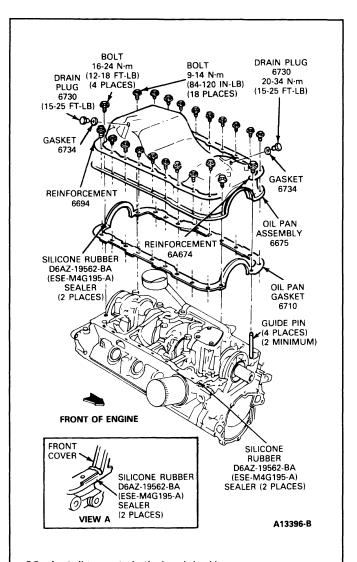
- Check clearance of each connecting rod bearing.
   Refer to procedure in Section 03-00,
   Engine—Gasoline—General Service.
- 23. After bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
- Turn the crankshaft throw to the bottom of its stroke. Push piston all the way down until connecting rod bearing seats on the crankshaft journal.
- 25. Install connecting rod cap. Tighten nuts to specification.
- After piston and connecting rod assemblies have been installed, check side clearance between connecting rods on each crankshaft journal.



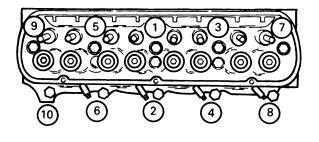
 Prime the oil pump and install oil pump, intermediate shaft, and pickup tube and screen assembly. Tighten oil pump bolts to specification.



- 28. Install crankshaft oil seal in front cover. (Refer to the Procedure in this section.)
- Install front cover seal, gasket, timing pointer and front cover. Tighten cover bolts to specification. (Refer to Procedure in this section.) Also, install crankshaft damper and pulley and torque bolt to specification.
- 30. Install new oil filter.
- 31. Install oil pan gasket and seal assembly. Install oil pan. Torque oil pan bolts to specification.



- 32. Install tappets in their original bores.
- Install tappet guide plate (roller tappet engines only) and torque screws and washers to specification.
- Position cylinder head gaskets on cylinder block. Install cylinder head locating dowels. Install cylinder heads.
- 35. Torque cylinder head bolts to specification, in the sequence shown.

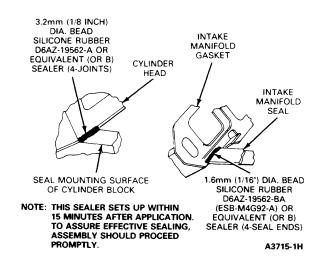


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 Install valve push rods, rocker arms, fulcrums, fulcrum guides, and torque fulcrum bolts to specification.

NOTE: If cylinder heads were completely disassembled, refer to Cylinder Head Disassembly and Assembly procedures in this section.

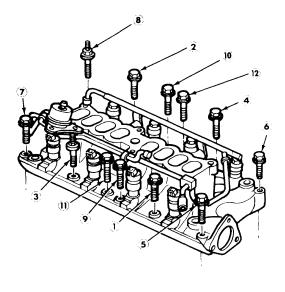
 Apply sealer at points shown and install intake manifold gaskets and seals.



 Install lower and upper intake manifold. Use guide pins to ease installation of intake manifold onto cylinder head.

NOTE: Sealer sets up in 15 minutes, so it is important that the assembly be completed promptly.

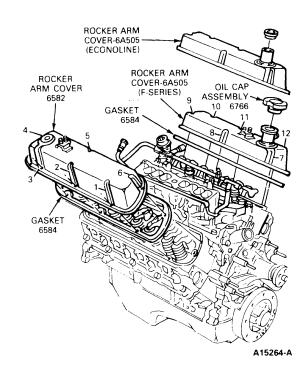
 Torque intake manifold bolts, in sequence, to specification.



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- 40. Install oil dipstick tube and indicator assembly.
- 41. Position valve rocker arm cover gasket in each cover and install valve rocker arm covers.

The valve rocker arm covers are tightened in 2 steps. Tighten bolts to specification. Two minutes later, tighten bolts to the same specification.



42. Install wiring harnesses, emission control system, fuel system, and ignition system and front end accessory drive components, by referring to Procedure in pertinent section.

#### **Tappet**

The internal parts of each hydraulic tappet assembly are matched sets. Do not mix the parts. Keep the assemblies intact until they are to be cleaned.

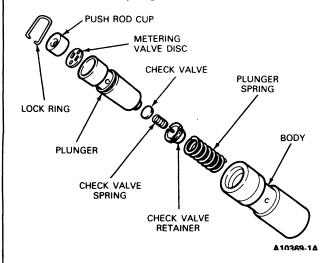
Tappets should always be tested after assembly. Refer to Section 03-00, Engine—Gasoline—General Service.

#### Disassembly

Disassemble and assemble each tappet separately. Keep the tappet assemblies in proper sequence so that they can be installed in their original bores.

- Grasp the lock ring with needlenose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.
- Remove the push rod cup, metering valve (disc), plunger and spring.

 Carefully remove the plunger spring, the check valve retainer and, the check valve spring and valve from the plunger.



#### **Assembly**

Tappet assembly is shown.

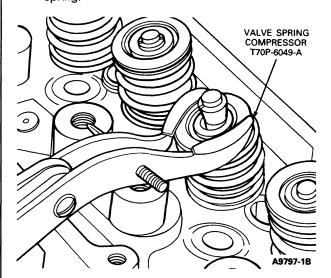
- Place the plunger upside down on a clean workbench.
- Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
- Position the check valve retainer over the check valve and spring and push the retainer down into place on the plunger.
- 4. Place the plunger spring, and then the plunger (open end up) into the tappet body.
- Position the metering valve (disc) in the plunger and then place the push rod cup in the plunger.
- Depress the plunger, and position the closed end of the lock ring in the groove of the tappet body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.
- 7. Use the tappet leakdown tester to fill the tappets with test fluid. Refer to Section 03-00, Engine—Gasoline—General Service.

#### **Cylinder Heads**

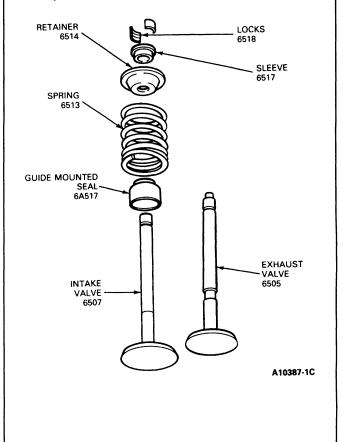
#### Disassembly

- Remove the exhaust manifolds and the spark plugs.
- Clean the carbon out of the cylinder head combustion chambers before removing the valves.

 Compress the valve spring using Valve Spring Compressor T70P-6049-A or equivalent. Remove the spring retainer locks and release the spring.



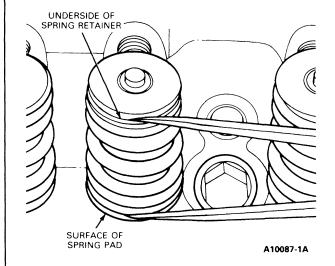
- Remove the sleeve, spring retainer, spring, guide mounted stem seal and valve. Discard the valve stem seals. Identify all valve parts.
- Clean, inspect and repair the cylinder head as required, or transfer all usable parts to a new cylinder head.



#### **Assembly**

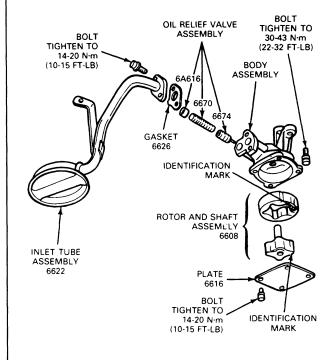
- Install each valve in the port from which it was removed or to which it was fitted. Install a new stem seal on the intake valve guide and exhaust valve guide.
- Install the valve spring over the valve, and then install the spring retainer and sleeve. Compress the spring using Valve Spring Compressor T70P-6049-A or equivalent and install the retainer locks.
- 3. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers. Check the dividers against a scale. If the assembled height is greater than specifications, install the necessary 0.762mm (0.030 inch) thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended height.

Do not install the spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.



Install the exhaust manifolds and the spark plugs.

 Drill a small hole and insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.



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# Assembly

The oil pump assembly is shown.

- Clean, inspect and oil all parts thoroughly.
- Install the oil pressure relieve valve plunger, spring and a new cap.
- Install the outer race and the inner rotor and shaft assembly. Be sure the dimple (identification mark) on the outer race is facing the same side as the identification mark on the rotor.

NOTE: The entire oil pump is serviced as an assembly. Install the cover and tighten the cover attaching bolts to 30-43 N·m (22-32 ft-lb).

# Oil Pump

#### Disassembly

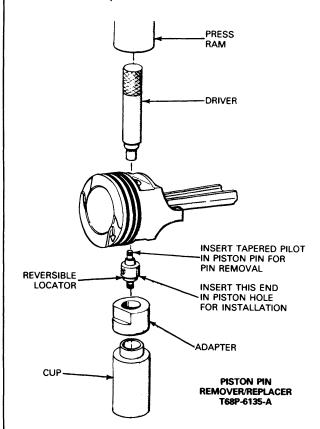
- Remove the oil inlet tube from the oil pump and remove the gaskets.
- Remove the cover attaching bolts, then remove the cover. Remove the inner rotor and shaft assembly. Then remove the outer race.

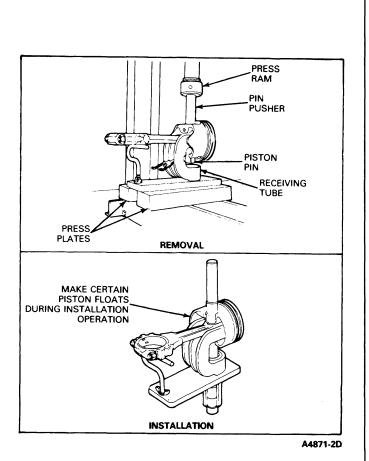
# Pistons and Connecting Rods

#### Disassembly

- Remove the bearing inserts from the connecting rod and cap.
- Mark the pistons to ensure assembly with the same rod and installation in the same cylinders from which they were removed.

 Using an arbor press and the Piston Pin Remover / Replacer T68P-6135-A or equivalent, press the piston pin from the piston and connecting rod. Remove the piston rings if they are to be replaced.





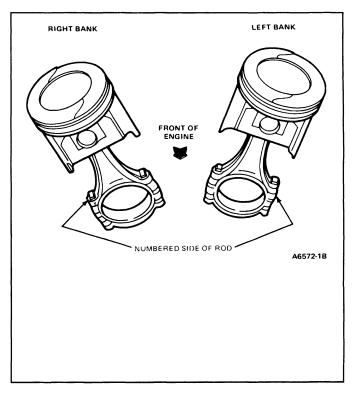
## **Assembly**

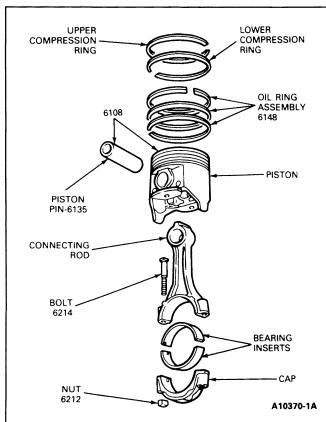
The piston, connecting rod and related parts are shown. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

 Apply a light coat of recommended quality engine oil SF to all parts. Assembly the piston to the connecting rod with the indentation in the piston positioned as shown.

On replacement connecting rods, install the large-chamfered side of the connecting rod bearing bore toward the crankshaft cheek; facing toward front of engine on the RH bank rods, and facing toward rear of engine on LH bank rods.





- Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an arbor press and Piston Pin Remover / Replacer T68P-6135-A or equivalent, press the piston pin through the piston and connecting rod until the pin is centered in the piston.
- 3. Check the end gap of all piston rings. Refer to Section 03-00, Engine—Gasoline—General Service. It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings using a piston ring installation tool of the proper size.
- 4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. Refer to Section 03-00, Engine—Gasoline—General Service. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.
- Ensure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

# Cylinder Block Assembly—(6009) Disassembly

- Mount the old engine in a workstand and remove all parts not furnished with the new cylinder block assembly following Engine Components Removal and Installation procedures.
- Remove the old cylinder block assembly from the workstand.

#### **Assembly**

- Clean the gasket and seal surfaces of all serviceable parts and assemblies.
- Position the new cylinder block assembly in a workstand.
- Transfer all serviceable parts removed from the old cylinder block assembly following Engine Components Removal and Installation procedures.
- Check all assembly clearances following Specifications listed at the end of this section, and correct as necessary.

### Cylinder Block—(6010)

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs. Refer to Section 03-00, Engine—Gasoline—General Service.

#### Disassembly

- Completely disassemble the old engine following Engine Components Removal and Installation procedures.
- Remember to ridge-ream the cylinder bores before removing piston assemblies.

#### **Assembly**

- Clean the gasket and seal surfaces of all serviceable parts and assemblies.
- 2. Position the new cylinder block in a workstand.
- Transfer all serviceable parts removed from the old cylinder block following Engine Components Removal and Installation procedures.
- Check all assembly clearances. Refer to Specifications and correct as necessary.

# **SPECIFICATIONS**

# **GENERAL SPECIFICATIONS**

| Engine                   | Bore and Stroke | Firing Order | Oil Pressure<br>Hot @ 20000 RPM |         | Engine Type<br>and Number |
|--------------------------|-----------------|--------------|---------------------------------|---------|---------------------------|
| _                        |                 |              | kPa                             | (PSI)   | of Cylinders              |
| 5.0L (302 CID) EFI V-8   | 4.00 x 3.00     | 15426378     | 275-413                         | (40-60) | O.H.V. V-8                |
| 5.8L (351 CID) EFI W-V-8 | 4.00 x 3.50     | 13726548     | 275-448                         | (40-65) | O.H.V. V-8                |

#### **CYLINDER HEAD**

| Engine   | Chamber Bo<br>Volume Diam |                 | Guide ore Valve Seat meter Width 1 |               | Valve Seat<br>Runout TIR<br>Maximum | Valve<br>Arrangement<br>Front to Rear | Gasket<br>Surface<br>Flatness            |                                   |
|--|---------------------------|-----------------|------------------------------------|---------------|-------------------------------------|---------------------------------------|--|-----------------------------------|
|  | C.C.③                     | Intake          | Exhaust                            | Intake        | Exhaust                             | maxiiiuiii                            | Front to near                            | 2                                 |
| 5.0L (302 CID) EFI V-8<br>5.8L (351 CID) EFI W-V-8 | 60.6-63.6                 | .3433-<br>.3443 | .3433-<br>.3443                    | .060-<br>.080 | .060-<br>.080                       | .002                                  | RT I-E-I-E-I-E-I-E<br>LT E-I-E-I-E-I-E-I | .003 in any 6 in.<br>.006 overall |

# VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

| Engine Rocker Arm Ru     | Posker Arm Push Rod   |                      |                        | Valve Tappet or L                 | Collapsed Tapped Gap (Clearance)    |         |         |
|--------------------------|-----------------------|----------------------|------------------------|-----------------------------------|-------------------------------------|---------|---------|
|                          | Runout TIR<br>Maximum | Standard<br>Diameter | Clearance<br>to Bore ① | Hydraulic Lifter<br>Leakdown Rate | Allowable                           | Desired |         |
| 5.0L (302 CID) EFI V-8   | 1.61                  | .015                 | .87408745              | .00070027                         | 10 to 50 seconds<br>for 1/16 travel | .071193 | .096165 |
| 5.8L (351 CID) EFI W-V-8 | 1.61                  | .015                 | .87408745              | .00070027                         | 10 to 50 seconds<br>for 1/16 travel | .098198 | .123173 |

#### VALVE SPRINGS

| Engine                   | Valve Spring Compression Pressure (lbs) @ Specified height |                                | Valve Spring<br>Free Length<br>(Approximate) |         | Valve<br>Asser<br>Hei | Valve Spring<br>Out of<br>Square |             |
|--------------------------|--|--------------------------------|--|---------|-----------------------|----------------------------------|-------------|
| }                        | Intake ①   | Exhaust                        | Intake                                       | Exhaust | Intake                | Exhaust                          | Maximum     |
| 5.0L (302 CID) EFI V-8   | 74-82 @ 1.78<br>196-212 @ 1.36                             | 76-84 @ 1.60<br>190-210 @ 1.20 | 2.04   | 1.85    | 1-43/64—1-45.64       | 1-37/64—1-39/64                  | 5/64 (.078) |
| 5.8L (351 CID) EFI W-V-8 | 74-82 @ 1.78<br>190-210 @ 1.20                             | 76-84 @ 1.60<br>190-10 @ 1.20  | 2.04   | 1.85    | 1-49/64—1-51/64       | 1-37/64—1-39/64                  | 5/64 (.078) |

①Service limit — 10% loss pressure.

#### **VALVES**

| Engine                   | Valve Stem to Gu | uide Clearance ① | Valve Head  | Valve Face Runout |         |  |
|--------------------------|------------------|------------------|-------------|-------------------|---------|--|
|                          | Intake           | Exhaust          | Intake      | Exhaust           | Maximum |  |
| 5.0L (302 CID) EFI V-8   | .00100027        | .00150032        | 1.690-1.694 | 1.439-1.463       | .002    |  |
| 5.8L (351 CID) EFI W-V-8 | .00100027        | .00150032        | 1.770-1.794 | 1.453-1.468       | .002    |  |

Service clearance — .0055.
 Valve face angle — 44°.

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<sup>1)</sup> Valve seat angle — 45°.2) Gasket surface finish — RMS 60-150.

③Compression pressure (PSI) of the lowest cylinder must be at least 75-1/2 of the highest to be within specification.

①Service limit .005. ②Time required for plunger to leakdown .0625 in. under load of 50 lbs. using leakdown fluid in tappet.

#### **VALVES (Continued)**

|  | Valve Stem Diameter |           |           |           |               |           |  |  |  |  |
|--|---------------------|-----------|-----------|-----------|---------------|-----------|--|--|--|--|
| Engine   | Stan                | dard      | .015 Ov   | versize   | .030 Oversize |           |  |  |  |  |
|  | Intake              | Exhaust   | Intake    | Exhaust   | Intake        | Exhaust   |  |  |  |  |
| 5.0L (302 CID) EFI V-8<br>5.8L (351 CID) EFI W-V-8 | .34163423           | .34113418 | .35663573 | .35613568 | .37163723     | .37113718 |  |  |  |  |

#### CAMSHAFT

| Engine                   | Lobe   | Lift ①  | Camshaf  | t End Play | Camshaft Journal to |
|--------------------------|--------|---------|----------|------------|---------------------|
|                          | Intake | Exhaust | End Play | Wear Limit | Bearing Clearance ② |
| 5.0L (302 CID) EFI V-8   | .2375  | .2474   | .001007  | .009       | .001003             |
| 5.8L (351 CID) EFI W-V-8 | .2780  | .2830   | .001007  | .009       | .001003             |

Maximum allowable lift loss — .005.

#### **CAMSHAFT DRIVE**

| Engine                   |         | Camshaft Journal<br>Diameter — Standard ① |         |         |         | Camshaft Bearing<br>Inside Diameter |         |         |         |         | Camshaft<br>Front<br>Bearing | Timing Chair<br>Deflection<br>Inches |
|--------------------------|---------|---|---------|---------|---------|-------------------------------------|---------|---------|---------|---------|------------------------------|--------------------------------------|
|                          | No. 1   | No. 2                                     | No. 3   | No. 4   | No. 5   | No. 1                               | No. 2   | No. 3   | No. 4   | No. 5   | Location 2                   | Maximum                              |
| 5.0L (302 CID) EFI V-8   | 2.0805- | 2.0655-                                   | 2.0505- | 2.0355- | 2.0205- | 2.0825-                             | 2.0675- | 2.0525- | 2.0375- | 2.0225- | 005 000                      | 500                                  |
| 5.8L (351 CID) EFI W-V-8 | 2.0815  | 2.0665                                    | 2.0515  | 2.0365  | 2.0215  | 2.0835                              | 2.0685  | 2.0535  | 2.0385  | 2.0235  | .005020                      | .500                                 |

①Camshaft journal runout — .005 TIR maximum.

# CYLINDER BLOCK

| Engine                      | Cylinder Bore<br>Diameter 1 | Main Bearing<br>Bore<br>Diameter 2 | Distributor Shaft<br>Bearing Bore<br>Diameter | Head Gasket<br>Surface Flatness   | Head Gasket<br>Surface Finish | Tappet Bore<br>Diameter |
|-----------------------------|-----------------------------|------------------------------------|---|-----------------------------------|-------------------------------|-------------------------|
| 5.0L (302 CID) EFI V-8      | 4.0004-4.0052               | 2.4412-2.4420                      | .45254541                                     | .003 in any 6 in.<br>.006 overall | RMS<br>60-150                 | .87528767               |
| 5.8L (351 CID) EFI<br>W-V-8 | 4.0000-4.0048               | 3.1922-3.1930                      | .51555170                                     | .003 in any 6 in.<br>.006 overall | RMS<br>60-150                 | .87528767               |

<sup>•</sup> Maximum out-of-round — .0015, Service limit — .005, Maximum taper service limit — .010, Cylinder bore surface finish — RMS 18-38, Bore tapes service limit — .010.

## **CRANKSHAFT AND FLYWHEEL**

| Engine                      | Main Bearing<br>Journal<br>Diameter 1 | Main Bearing<br>Journal Runout<br>TIR Maximum 2 | Main Bearing<br>Thrust Face<br>Runout<br>TIR Maximum | Main Bearing<br>Journal Taper<br>Maximum Per<br>Inch | Thrust Bearing<br>Journal Length | Main and<br>Rod Bearing<br>Journal Finish<br>RMS Maximum | Main Bearing<br>Thrust Face<br>Finish<br>RMS Maximum |
|-----------------------------|---------------------------------------|---|--|--|----------------------------------|--|--|
| 5.0L (302 CID) EFI<br>V-8   | 2.2482-2.2490                         | .002  | .001   | .0005  | 1.137-1.139                      | 12   | 25 Front—<br>20 Rear                                 |
| 5.8L (351 CID) EFI<br>W-V-8 | 2.9994-3.0002                         | .002  | .001   | .0005  | 1.137-1.139                      | 12   | 25 Front—<br>20 Rear                                 |

①Maximum out-of-round — .0006.

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Service limit — .006 maximum.

<sup>2)</sup> Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

<sup>2</sup> Crankshaft to rear face of block runout. TIR maximum .005.

Service limit — .005.

#### **CRANKSHAFT AND FLYWHEEL (Continued)**

| Engine<br>Assembled      | Connecting Rod<br>Journal Dlameter(1) | Connecting Rod<br>Journal Taper<br>Per Inch Maximum | Crankshaft Free<br>End Play② | Flywheel<br>Clutch Face<br>Run-Out |
|--------------------------|---------------------------------------|---|------------------------------|------------------------------------|
| 5.0L (302 CID) EFI V-8   | 2.1228-2.1236                         | .0006   | .004008                      | 0.010                              |
| 5.8L (351 CID) EFI W-V-8 | 2.3103-2.3111                         | .0006   | .004008                      | 0.010                              |

①Maximum out-of-round — .0006.

# **CRANKSHAFT BEARINGS**

|  |                        | g Rod Bearing To<br>learance Selective |                                   | Main Bearing to Crankshaft Clearance Selective Fit |                |                                  |  |
|--|------------------------|--|-----------------------------------|--|----------------|----------------------------------|--|
| Engine   | Desired                | Allowable                              | Bearing Wall<br>Thickness Std. 1) | Desired  | Allowable      | Bearing Wall<br>Thickness Std. 1 |  |
| 5.0L (302 CID) EFI V-8<br>5.8L (351 CID) EFI W-V-8 | .00080015<br>.00080015 | .00070024<br>.00080025                 | .05720577<br>.05720577            | ②<br>.00080015                                     | ③<br>.00080026 | .09570960                        |  |

 $\ensuremath{\text{\textcircled{1}}}\xspace For .002$  undersize add .001 to standard wall thickness.

②#1 Bearing — .0001-.0015. All others — .0005-.0015. ③#1 Bearing — .0001-.0020. All others — .0005-.0024.

**4** #1 Upper only .0961 — .0966. All others .0957-.0962.

#### **CONNECTING ROD**

|                          | Piston Pin<br>Bore | Rod Bearing   | Rod Length          |              | lod Alignment<br>tal Difference | Rod To<br>Crankshaft            |
|--------------------------|--------------------|---------------|---------------------|--------------|---------------------------------|---------------------------------|
| Engine                   | or Bushing<br>I.D. | Bore I.D.①    | Center to<br>Center | Twist3 Bend2 |                                 | Assembled<br>Side<br>Clearance③ |
| 5.0L (302 CID) EFI V-8   | .90969112          | 2.2390-2.2398 | 5.0885-5.0915       | .024         | .012                            | .010020                         |
| 5.8L (351 CID) EFI W-V-8 | .90979112          | 2.4265-2.4273 | 5.9545-5.9575       | .024         | .012                            | .010020                         |

 $<sup>\</sup>textcircled{1} \textbf{Connecting rod bearing bore maximum out-of-round} -- .0004$ 

# **PISTON**

|  |                               | Diameter 1)                    |                                | Piston to                    |                                | Ring Groo          | ove Width | Compression          |
|--|-------------------------------|--------------------------------|--------------------------------|------------------------------|--------------------------------|--------------------|-----------|----------------------|
| Engine   | Coded Red                     | Coded Blue                     | .003 Oversize                  | Bore Clearance Selective Fit | Piston Pin<br>Bore<br>Diameter | Тор                | Bottom    | Oil                  |
| 5.0L (302 CID) EFI V-8<br>5.8L (351 CID) EFI W-V-8 | 3.9989-3.995<br>3.9978-3.9984 | 4.0001-4.0007<br>3.9990-3.9996 | 4.0013-4.0019<br>4.0002-4.0008 | .00140022<br>.00180026       | .91239126<br>.91249127         | .060061<br>.080081 |           | .15871597<br>.188189 |

①Measured at the piston pin bore centerline at 90° to the pin.

#### PISTON PIN

|  |                            | Diameter               |                        |                        | To Piston Pin          | To Connecting Rod                    |
|--|----------------------------|------------------------|------------------------|------------------------|------------------------|--------------------------------------|
| Engine   | Length                     | Standard               | .001 Oversize          | .002 Oversize          | Bore Clearance ①       | Bushing Clearance                    |
| 5.0L (302 CID) EFI V-8<br>5.8L (351 CID) EFI W-V-8 | 3.010-3.040<br>3.010-3.040 | .91199124<br>.91199124 | .91309133<br>.91309133 | .91409143<br>.91409143 | .00020004<br>.00030005 | Interference Fit<br>Interference Fit |

①Selective fit.

Service limit — .012.

② Pin bushing and crankshaft bore must be parallel and in same vertical plane with specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

<sup>3</sup> Service limit — .023

#### **PISTON RINGS**

|  | Ring Width           |                       | Sid                  | Side Clearance ①      |      |                    | Ring Gap              |                    |  |
|--|----------------------|-----------------------|----------------------|-----------------------|------|--------------------|-----------------------|--------------------|--|
| Engine   | Top<br>Compression   | Bottom<br>Compression | Top<br>Compression   | Bottom<br>Compression | Oil  | Top<br>Compression | Bottom<br>Compression | Oil②               |  |
| 5.0L (302 CID) EFI V-8<br>5.8L (351 CID) EFI W V-8 | .05770587<br>.078077 | .05770587<br>.078077  | .00130033<br>.002004 | .002004               | Snug | .010020<br>In Gage | .010020<br>In Gage    | .015055<br>In Gage |  |

 $<sup>\</sup>label{eq:service_service} \textbf{(1)Service limit} - .002 \ \text{maximum increase in clearance}.$ 

# OIL PUMP AND OIL CAPACITY

|                           | Relief Valve Spring              | Driveshaft to        | Relief Valve            | Rotor                     | Outer Race              | Eng            | ine Oil Capaci     | ty①    |
|---------------------------|----------------------------------|----------------------|-------------------------|---------------------------|-------------------------|----------------|--------------------|--------|
| Engine                    | Pressure Lbs. @ Specified Length | Housing<br>Clearance | to Housing<br>Clearance | Assembly End<br>Clearance | to Housing<br>Clearance | U.S.<br>Quarts | imperial<br>Quarts | Litres |
| 5.0L (302 CID)<br>EFI V-8 | 10.6-12.2 @ 1.74                 | .00150030            | .00150030               | .004 Maximum              | .001013                 | 5              | 4.2                | 4.7    |
| 5.8L (351 CID)<br>EFI V-8 | 18.2-20.2 @ 2.49                 | .00150030            | .00150030               | .004 Maximum              | .001003                 | 5              | 4.2                | 4.7    |

①Add 1 U.S. quart (or equivalent in imperial quarts or liters) when replacing filter.

#### FUEL PUMP - MECHANICAL

| Engine                   | Static Pressure (PSI)① | Volume Flow — Minimum (1) 2 | Eccentric Total Lift — Inches |
|--------------------------|------------------------|-----------------------------|-------------------------------|
| 5.8L (351 CID) EFI W V-8 | 6.0-8.0                | 1 pint in 20 seconds        | .690710                       |

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②Steel rail.

①On the engine with temperature normalized and at normal curb idle speed, in neutral. ②The inside diameter of the smallest passage in the test flow circuit must not be less than .220.

#### TORQUE LIMITS — 5.0L (302 CID) EFI V-8 — 5.8L (351 CID) EFI W-V-8

NOTE: All values in N•m (ft-lbs), unless otherwise noted. Oil threads with engine oil unless the threads require oil or water-resistant sealer. The standard torque limits listed below are applicable for all functions not listed in the special torque chart.

| 1/4-20     | 5/16-18       | 5/16-24       | 3/8-16        | 3/8-24        | 7/16-14       | 7/16-20       | 1/2-13        | 9/16-18          |
|------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|------------------|
| 8-12 (6-9) | 17-24 (12-18) | 19-27 (14-20) | 30-43 (22-32) | 37-51 (27-38) | 61-77 (45-57) | 55-81 (40-60) | 75-81 (55-60) | 116-162 (85-120) |

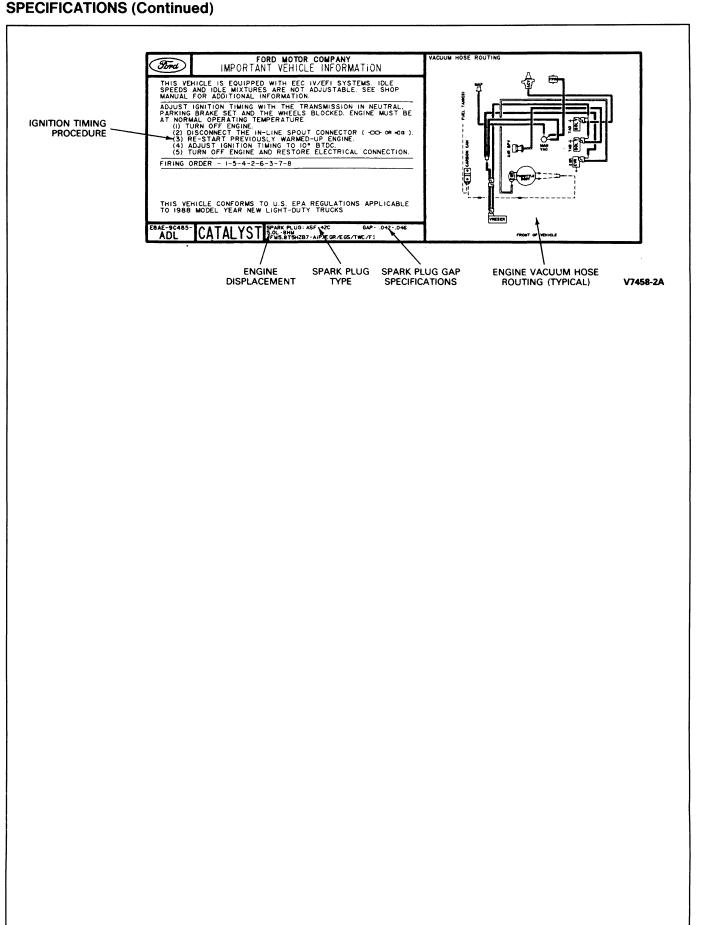
#### PIPE THREADS

| 1/8-27     | 1/4-18        | 3/8-18        | 1/2-14        |
|------------|---------------|---------------|---------------|
| 7-11 (5-8) | 17-24 (12-18) | 30-44 (22-33) | 34-47 (25-35) |

|   | Toro                                | ļue                 |
|---|-------------------------------------|---------------------|
| Item  | N-m                                 | (ft-lbs)            |
| Camshaft Sprocket — Gear to Camshaft                                  | 55-61                               | (40-45)             |
| Camshaft Thrust Plate to Cylinder Block                               | 13-16                               | ( 9-12)             |
| Connecting Rod Nut — 5.0L (302 CID) V-8<br>— 5.8L (351 CID) W-V-8     | 26-32<br>55-61                      | (19-24)<br>(40-45)  |
| Cylinder Front Cover  | 17-24                               | (12-18)             |
| Cylinder Head Bolts   | ①                                   | 2                   |
| Damper to Crankshaft  | 95-122                              | (70-90)             |
| EGR Valve to Carburetor Spacer or Intake Manifold                     | 17-24                               | (12-18)             |
| Fuel Pump to Cylinder Block of Front Cover                            | 26-36                               | (19-27)             |
| Flywheel to Crankshaft  | 102-115                             | (75-85)             |
| Main Bearing Cap Bolts — 5.0L (302 CID) V-8<br>— 5.8L (351 CID) W-V-8 | 82-94<br>129-142                    | (60-70)<br>(95-105) |
| Manifold to Cylinder Head — Intake                                    | 32-33                               | (23-25)             |
| Manifold to Cylinder Head — Exhaust                                   | 25-32                               | (18-24)             |
| Intake Manifold Vacuum Fittings — Aluminum — Cast Iron                | 8-13<br>32-37                       | ( 6-10)<br>(23-28)  |
| Intake Manifold Pipe Fittings — Aluminum<br>— Cast Iron               | 17-24<br>32-37                      | (12-18)<br>(23-28)  |
| Oil Inlet Tube to Main Bearing Cap                                    | 30-43                               | (22-32)             |
| Thermactor Pump Bracket to Cylinder Block                             | 44-67                               | (30-45)             |
| Distributor Clamp Down  | 24-32                               | (17-25)             |
| Oil Filter Insert to Cylinder Block/Adaptor                           | 28-40                               | (20-30)             |
| Oil Filter to Adaptor or Cylinder Block                               | 1/2 turn after g<br>sealing surface |                     |
| Oil Inlet Tube Pump   | 14-20                               | (10-15)             |
| Oil Pan Drain Plug  | 21-33                               | (15-25)             |
| Oil Pan to Cylinder Block   | 13-14                               | ( 9-11)             |
| Oil Pump to Cylinder Block  | 30-43                               | (22-32)             |
| Pulley to Damper Bolt   | 48-67                               | (35-50)             |
| Rocker Arm Stud/Bolt to Cylinder Head                                 | 25-33                               | (18-25)             |
| Spark Plug to Cylinder Head   | 14-20                               | (10-15)             |
| Valve Rocker Arm Cover  | 4-6                                 | ( 3-5 )             |
| Water Outlet Housing  | 13-16                               | ( 9-12)             |
| Water Pump to Block/Front Cover                                       | 17-24                               | (12-18)             |
| Air Pump and Alternator Bracket to Cylinder Head — Bolt               | 41-54                               | (30-40)             |
| A/C Compressor and Power Steering Pump Bracket                        | 54-67                               | (40-50)             |
| Thermactor Pump Pivot Bolt  | 41-54                               | (30-40)             |
| Alternator Pivot Bolt   | 54-67                               | (40-50)             |
| Thermactor Pump Pulley to Pump Hub                                    | 12-15                               | (8.5-11 in-lbs)     |

①5.0L (302 CID) EFI V-8 — Tighten in steps: first to 75-88 N·m (55-65 ft-lbs.) then to 88-97 N·m (65-72 ft-lbs.) ②5.8L (351 CID) EFI W-V-8 — Tighten in steps: first to 115 N·m (85 ft-lbs.) then to 129 N·m (95 ft-lbs.), final to 143-151 N·m (105-112 ft-lbs).

CA4961-J



# **SPECIAL SERVICE TOOLS**

| Tool Number                          | Description                                  |
|--------------------------------------|--|
| D79P-100-A                           | Impact Slide Hammer                          |
| T50T-100-A                           | Impact Slide Hammer                          |
| T59L-100-B                           | Impact Slide Hammer                          |
| T58L-101-B                           | Puller Attachment                            |
| D80L-522-A                           | Damper Remover                               |
| TOOL-4201-C                          | Dial Indicator with Bracketry                |
| T70P-6000                            | Engine Lifting Brackets                      |
| T75T-6000-A                          | Engine Lifting Plate                         |
| T64L-6011-EA                         | Cylinder Ridge Reamer                        |
| T73L-6011-A                          | Cylinder Hone Set                            |
| T61P-6019-B                          | Front Cover Aligner                          |
| T70P-6049-A                          | Valve Spring Compressor                      |
| T68P-6135-A                          | Piston Pin Remover/Replacer                  |
| T65L-6250-A                          | Camshaft Bearing Set                         |
| T52L-6306-AEE                        | Crankshaft Damper & Sprocket Replacer        |
| T58P-6316-D                          | Crankshaft Damper Remover                    |
| T79T-6316-A                          | Damper Remover/Replacer Tool                 |
| TOOL-6331-E — or TOOL-6331 (351 CID) | Upper Main Bearing Insert Remover & Replacer |
| T74P-6375-A                          | Flywheel Holding Tool                        |
| T75L-6392-A                          | Clutch Housing Alignment Tool                |
| TOOL-6500-E                          | Hydraulic Tappet Leakdown Tester             |
| T71P-6513-B                          | Tappet Bleed Down Wrench                     |
| TOOL-6513-DD                         | Valve/Clutch Spring Tester                   |
| T70P-6049-A                          | Valve Spring Compressor                      |
| TOOL-6565-AB                         | Cup Shaped Adapter                           |
| T73L-6600-A                          | Pressure Gauge                               |
| D79P-6666-A                          | Spark Plug Boot Puller                       |
| T74P-6666-A                          | Spark Plug Wire Remover                      |
| D79L-6731-A                          | Oil Filter Wrench                            |
| D79L-6731-B                          | Oil Filter Wrench                            |
| T74P-7137-A                          | Pilot Bearing Replacer                       |
| T70P-6B070-A                         | Front Cover Seal Replacer                    |
| T70P-6B070-B                         | Front Cover Seal Remover                     |
| D81L-6002-C                          | Piston Ring Compressor                       |
| T70L-6500-A                          | Hydraulic Tappet Puller                      |

CA6534-2G

# ROTUNDA EQUIPMENT

| Model Number | Description       |  |
|--------------|-------------------|--|
| 066-00017    | Transmission Jack |  |

CA7334-1D

03-01C-1

# SECTION 03-01C Engine — 7.5L (460 CID) EFI V-8

| SUBJECT PAGE                             | SUBJECT PAGE                                  |
|--|---|
| ADJUSTMENTS                              | IN-VEHICLE SERVICE (Cont'd.)                  |
| Valve Clearance03-01C-3                  | Exhaust Manifolds03-01C-16                    |
| DESCRIPTION                              | Flywheel03-01C-23                             |
| Cooling System03-01C-3                   | Front Cover and Timing Chain03-01C-18         |
| Crankcase Ventilation System03-01C-2     | Front Oil Seal03-01C-20                       |
| Emission Calibration Label               | Intake Manifold03-01C-12                      |
| Engine03-01C-2                           | Main Bearing                                  |
| Exhaust Emission Control System03-01C-2  | Oil Filter03-01C-29                           |
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| DISASSEMBLY AND ASSEMBLY                 | Pistons and Connecting Rods03-01C-26          |
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| Cylinder Block                           | Adjuster03-01C-10                             |
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| Valve Tappet03-01C-40                    | Valve Tappet03-01C-14                         |
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| Camshaft Rear Bearing Bore Plug03-01C-23 | Camshaft Bearings03-01C-39                    |
| Clutch Pilot Bearing03-01C-28            | Crankshaft03-01C-36                           |
| Connecting Rod Bearing03-01C-26          | Engine — E-250 — E-35003-01C-29               |
| Crankcase Ventilation System03-01C-9     | Engine — F-250 — F-350 — F-Super Duty         |
| Crankshaft Rear Oil Seal03-01C-25        | Chassis Cab and Motor Home                    |
| Cylinder Heads03-01C-15                  | Chassis03-01C-32                              |
| Electronic Fuel Injection03-01C-4        | SPECIAL SERVICE TOOLS03-01C-48                |
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| Engine Front Supports03-01C-4            | VEHICLE APPLICATION03-01C-1                   |
| Engine Rear Support03-01C-5              |   |

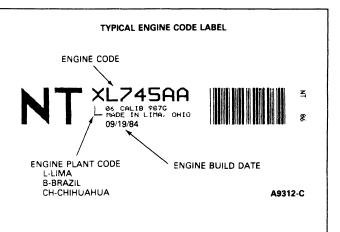
#### **VEHICLE APPLICATION**

F-250 and F-350 and F-Super Duty Chassis Cab and Motor Home Chassis, E-250 and E-350 Vehicles

# **DESCRIPTION**

#### **Engine Code Information Label**

An engine code information label located on the rocker arm cover contains an engine build date, an engine plant code and an engine code.



# **DESCRIPTION (Continued)**

#### **Engine**

The 7.5L (460 CID) EFI V-8 engine has a cast-iron cylinder block. The crankshaft is precision-cast, nodular iron alloy and has five main bearings. The pistons are autothermic-cast aluminum alloy, tin plated. Valve rocker arms are pedestal-mounted and the tappets are hydraulic. Large, chrome-plated intake and exhaust valves provide optimum breathing. A low restriction air cleaner is utilized for maximum clean air intake. Refer to the chart under Specifications for complete specifications.

The 7.5L (460 CID) EFI engine is standard equipment for F-Super Duty Motor Home Chassis vehicles.

The 7.5L (460 CID) EFI engine is optional for E-250 and E-350, and F-250 and F-350 and F-Super Duty.

#### **Emission Calibration Label**

The emission calibration number label is located on the LH side door or LH door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

NOTE: It is imperative that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.

CALIBRATION ÉTALONNAGE CALIBRACIÓN



8-76A-ROO EBAE-6E061-ABY

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#### **Exhaust Emission Control System**

Operation, removal, installation and required maintenance of the exhaust emission control devices used on the 7.5L (460 CID) EFI engine are covered in the Engine / Emissions Diagnosis\* manual.

## **Crankcase Ventilation System**

The 7.5L (460 CID) EFI V-8 engine is equipped with a positive closed-type crankcase ventilation system to purge the crankcase vapors.

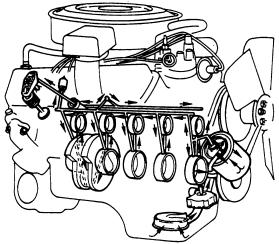
#### **Lubrication System**

The heart of the lubrication system is a full-pressure cast-iron pump. The high capacity "G-rotor" pump is driven by a hex shaft from the distributor. The pressure is relief-valve controlled.

Oil is directed through a drilled oil passage to the full-flow oil filter and from the filter to main oil galleries intersecting the valve guide bores. A drilled gallery (crossover) at the rear of the tappet chamber routes oil to the LH bank. The main, connecting rod, and camshaft bearings are supplied with oil from the RH oil gallery.

Oil flow to the camshaft sprocket and timing chain is through an annulus and drilled passage at the front of the No. 1 camshaft bearing. Oil flow to the rocker arms is through the tappets and up the push rods to the arms.

All vehicles are equipped with an oil cooler. The cooler is block mounted. The compact oil to water heat exchanger mounts directly to the left hand side of the engine, at the oil filter mounting pad.

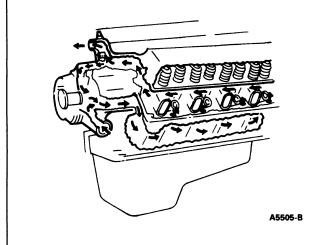


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# **DESCRIPTION (Continued)**

# **Cooling System**

The cooling system is a series-parallel flow design. Coolant flow is from the water pump through passages in the front cover (both sides) to the cylinder block. Flow continues through the block to the rear and up through the deck or head faces. It then travels forward through the cylinder heads to the water crossover at the front of the intake manifold, through the water outlet (thermostat housing) and to the top of the radiator.



#### DIAGNOSIS AND TESTING

Refer to Diagnosis and Testing in Section 03-00, Engine—Gasoline—General Service.

# **ADJUSTMENTS**

# **Valve Clearance**

The valve arrangement on the LH bank is E-I-E-I-E-I and on the RH bank is I-E-I-E-I-E.

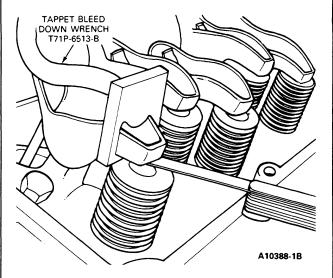
A 1.52mm (0.060-inch) shorter push rod or a 1.52mm (0.060-inch) longer push rod is available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem-to-valve rocker arm clearance should be within specifications as outlined. With the hydraulic tappet completely collapsed, repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if not compensated for, the hydraulic valve tappet will cease to function and the valve will be held open.

The use of a positive stop valve rocker arm bolt eliminates the need for valve clearance adjustment. However to obtain accurate valve clearance measurements, it is important that all components be serviceable and installed to specification.

To determine whether a shorter or a longer push rod is necessary, perform the following check:

- Install an auxiliary starter switch. Crank the engine with the ignition switch in OFF until the No. 1 piston is on TDC after the compression stroke.
- 2. With the crankshaft in the positions designated in the following Steps 3, 4 and 5, position the hydraulic tappet compressor Tappet Bleed Down Wrench T7 1P-6513-B or equivalent on the rocker arm. Slowly apply pressure to bleed down the hydraulic tappet until the plunger is completely bottomed. Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge. If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.



 With the No. 1 piston at TDC at the end of the compression stroke as shown in POSITION NO. 1, check clearances on the following valves:

No. 1 Intake No. 1 Exhaust

No. 3 Intake No. 4 Exhaust

No. 7 Intake No. 5 Exhaust

No. 8 Intake No. 8 Exhaust

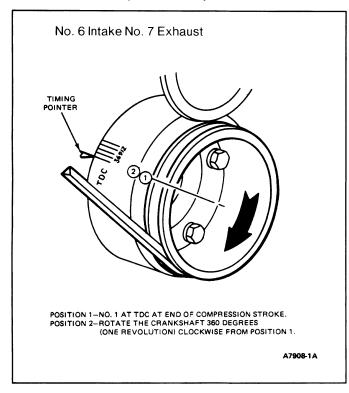
 After checking the clearance on these valves, rotate the crankshaft 360 degrees to POSITION NO. 2 as shown, then check the following valves:

No. 2 Intake No. 2 Exhaust

No. 4 Intake No. 3 Exhaust

No. 5 Intake No. 6 Exhaust

# **ADJUSTMENTS (Continued)**



#### **IN-VEHICLE SERVICE**

The following procedures can be performed with the engine in the vehicle.

When installing nuts or bolts (refer to Torque Specifications listed at the end of this section), oil the threads with lightweight engine oil. **Do not oil threads requiring oil-resistant or water-resistant sealer.** 

Refer to Section 03-00, General Gasoline Engine Service, for cleaning, inspection and testing procedures.

# **Electronic Fuel Injection**

Refer to Section 03-04C, for service of EFI components.

# **Engine Front Supports**

Front supports are located on each side of the cylinder block. The following procedures apply to either support:

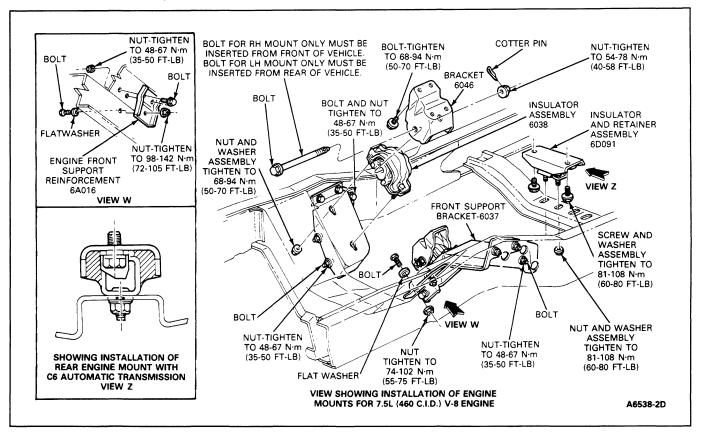
#### E-250 - E-350

#### Removal

- Support the engine with a jack and a wood block placed under the oil pan.
- Remove the locknuts from the bolts attaching the support bracket to the frame crossmember and frame side rail.
- 3. Remove the through bolt attaching the engine support bracket to the insulator.
- 4. Raise the engine with the jack, until the insulator is clear of the cup-shaped engine bracket.
- Remove the insulator and frame bracket as an assembly.
- 6. Remove the nuts attaching the insulator to the frame bracket.

#### Installation

- Assemble the insulator to the frame bracket and install the attaching nuts. The insulator should be installed so that the word TOP is visible on either side of the engine. Tighten the attaching nuts to 68-94 N·m (50-70 ft-lb).
- Position the insulator and frame bracket assembly to the engine insulator bracket and the frame crossmember. Install the through bolt attaching the insulator to the engine bracket. The through bolt for the RH insulator must be installed from the front of the engine. The through bolt for the LH insulator must be installed from the rear of the engine. Tighten the nut to 55-78 N·m (40-58 ft-lb) and install the cotter pin. Lower the engine.
- Install the locknuts on the bolts attaching the frame bracket to the crossmember. Tighten the frame bracket attaching bolt locknuts to 48-67 N·m (35-50 ft-lb). Tighten the crossmember bolts and locknuts on the LH support bracket to 98-142 N·m (72-105 ft-lb). Remove the jack and wood block.



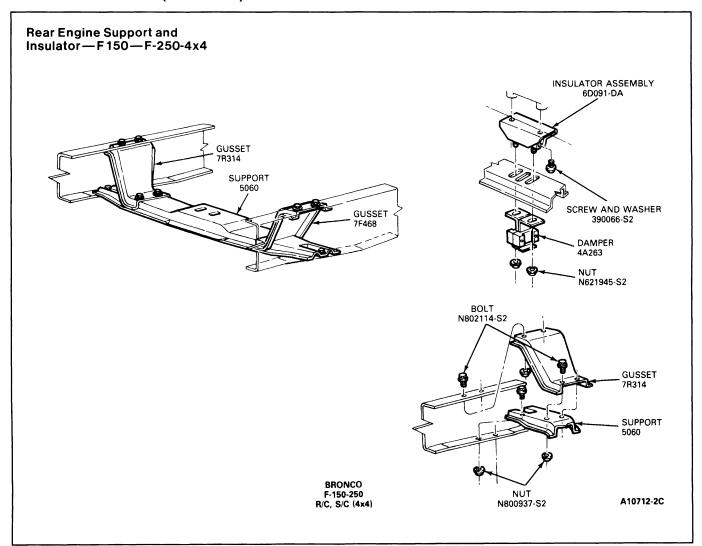
# **Engine Rear Support**

#### Removal

- Remove the attaching bolts, nut and washer as previously outlined.
- Raise the transmission slightly to provide clearance; then, remove the insulator and insulator retainer.

#### Installation

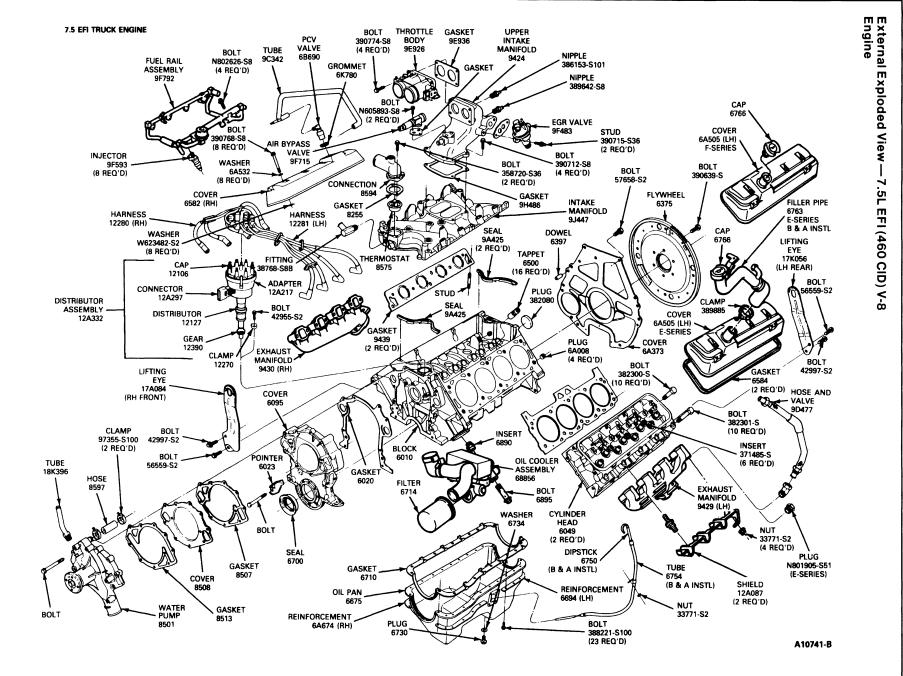
- Position the insulator and retainer as previously outlined. Install the insulator-to-extension housing bolts and lockwashers. Tighten to 68-94 N·m (50-70 ft-lb) on E-250—E-350; 60-80 N·m (44-59 ft-lb) on F-250—F-350 and F-Super Duty.
- Lower the transmission and install the insulator-to-frame crossmember nuts. Tighten the nuts to 68-94 N·m (50-70 ft-lb) on E and F-Series.



# **Engine Components**

The following exploded views of the 7.5L EFI engine are typical and are references for procedures outlined. The parts descriptions and basic numbers in the illustration keys correspond with the Ford Master Parts Catalog.

#### IN-VEHICLE xternal Exploded View S Ш CAP RVIC 6766 COVER 6A505 (LH) m F-SERIES (Continued) BOLT 390639-S FILLER PIPE 6763 E-SERIES B & A INSTL CAP



IN-VEHICLE

S

ERVICE

(Continued)

#### Internal Exploded View Engine TAPPET 6500 BAFFLE RETAINER BOLT KEY PLUG 7.5L EFI TRUCK ENGINE (15 REQ'D) 6518 (32 REQ'D) 385658-S2 6514 6A531 382080 PLUG (16 REQ'D) (16 REQ'D) (16 REQ'D) 87837-S FULCRUM **SPRING** PLUG 6A528 6513 87837-S PLUG (16 REQ'D) (16 REQ'D) 6A008 DRY SEAL - INTAKE CYLINDER ROCKER ARM (4 REQ'D) **BLOCK** 6564 -6A517 6010 (8 REQ'D) (16 REQ'D) PUSH ROD BOLT BEARING 6565 382300-S 6261 (5 PLACES) (16 REQ'D) (10 REQ'D) BOLT CYLINDER HEAD 382301-S CAMSHAFT 7.5L EFI (460 CID) V-8 (10 REQ'D) 6049 **THRUST** 6250 PLATE WET SEAL - EXHAUST SEAT 6269 6A517 6057 (8 REQ'D) (8 REQ'D) INSERT SPROCKET BOLT 371485-S **EXHAUST VALVE** 6256 358761-S (6 REQ'D) 6505 (2 REQ'D) (8 REQ'D) DRIVE SHAFT SPARK PLUG WASHER 6A618 12405 INTAKE VALVE 6278 NUT (8 REQ'D) 6507 382802-S2 (8 REQ'D) BOLT 57658-S2 COVER AND OIL PUMP SCREEN BOLT 42910-S DOWEL 390639-S (2 REQ'D) 6397 GASKET **DOWEL** (2 REQ'D) 73328 BOLT BOLT 43001-S2 MAIN 57647-S (2 REQ'D) BEARING **FLYWHEEL** 6333 6375 (4 PLACES) THRUST BEARING PISTON RING SET PISTON 6337 6110 (8 REQ'D) PIN 6148 6135 (8 REQ'D) (8 REQ'D) COVER 6A373 BOLT 6214 OIL SEAL ROD (16 REQ'D) ASSEMBLY 6100 6701 ROD (2 REQ'D) CRANKSHAFT 6200 MAIN (8 REQ'D) BEARING **TIMING CHAIN** 6A338 6268 (4 PLACES) THRUST BEARING BEARING WASHER 6211 6A339 6310 SPACER (16 REQ'D) BEARING BEARING 6359 CAP CAP 6325 DAMPER BEARING 6316 6210 CAP (8 REQ'D) WASHER 6330 6212 6378 BEARING (16 REQ'D) 386574-S CAP BOLT (9 REQ'D) SPROCKET 6334 376706-S 6306 STUD 7.5L EFI TRUCK ENGINE BEARING CAP A10742-2A 388448-S 6329

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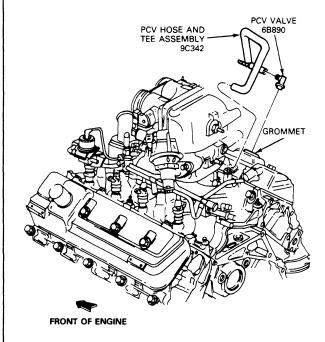
# Crankcase Ventilation System F-250—F-350 — F-Super Duty

#### Removal

- Remove ventilation intake hose from the air cleaner and the oil fill tube on LH rocker cover.
- Disconnect and remove ventilation filter pack from dirty side of air cleaner assembly.
- 3. Remove the PCV valve from the grommet on the RH rocker cover.
- Disconnect the crankcase ventilation hose at the upper intake manifold and at the evaporative emission harness.

#### Installation

- Install the PCV valve and hose into the grommet on the RH rocker cover.
- Install the ventilation hose at the emission harness and at the upper intake manifold.
- Install a new filter pack in air cleaner assembly.
- Install the ventilation intake hose to the oil fill tube and the air cleaner.
- 5. Start the engine and check for leaks.



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#### E-250-E-350

#### Removal

- Remove ventilation intake hose from the air cleaner and the oil fill tube on the LH rocker cover.
- Disconnect and remove ventilation filter pack from dirty side of air cleaner assembly.
- Remove the PCV valve from the grommet on the RH rocker cover.
- Disconnect the crankcase ventilation hose at the upper intake manifold and at the evaporative emission harness.

#### Installation

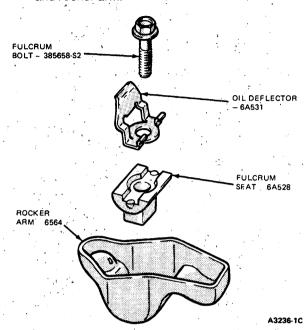
- Insert the PCV valve and hose into the grommet in the RH rocker arm cover.
- Install the ventilation hose at the emission harness and at the upper intake manifold.
- Install a new filter pack in the air cleaner assembly.
- 4. Install the ventilation intake to the oil fill tube and the air cleaner.
- Start the engine and check for leaks.

# Valve Rocker Arm Cover and Rocker Arm F-Series and E-Series

#### Removal

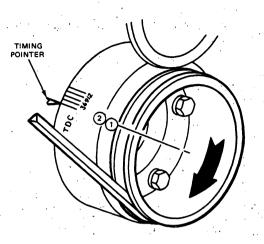
- Disconnect battery(s).
- 2. Remove air cleaner and intake duct assembly.
- Remove thermactor exhaust air supply control valve and bracket assembly, and ignition coil mounting bracket.
- Disconnect MTA hose at thermactor valve.
- Disconnect thermactor air control valve to air pump hose and tube inlet assembly.
- Disconnect spark plug wires from spark plugs using Spark Plug Wire Remover T74P-6666-A or equivalent and position wires out of the way.
- 7. Remove crankcase ventilation PCV valve from the valve rocker arm cover (for RH cover).
- Position wiring and vacuum harnesses to gain access in order to remove RH valve rocker arm cover.
- 9. Remove the valve rocker arm cover(s).

 Remove fulcrum bolt, oil deflector, fulcrum seat and rocker arm.



#### Installation

- Apply Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stems, the rocker arm and fulcrum seats.
- Position the No. 1 piston at TDC at the end of the compression stroke (POSITION 1). Install the rocker arm, fulcrum seat, oil deflector and fulcrum bolt on the following valves:
  - No. 1 Intake No. 1 Exhaust
  - No. 3 Intake No. 8 Exhaust
  - No. 7 Intake No. 5 Exhaust
  - No. 8 Intake No. 4 Exhaust
- Position the crankshaft in POSITION 1 and install the rocker arm, fulcrum seat, oil deflector and a bolt on the following valves:
  - No. 2 Intake No. 2 Exhaust
  - No. 4 Intake No. 3 Exhaust
  - No. 5 Intake No. 6 Exhaust
  - No. 6 Intake No. 7 Exhaust



POSITION 1—NO. 1 AT TDC AT END OF COMPRESSION STROKE.
POSITION 2—ROTATE THE CRANKSHAFT 360 DEGREES
(ONE REVOLUTION) CLOCKWISE FROM POSITION 1.

47000 4 4

Ensure the fulcrum seat base is inserted into its slot on the cylinder head before tightening the fulcrum bolts. Tighten the fulcrum bolt to 25-33 N·m (18-25 ft-lbs). Adjust the valve clearance as outlined under Adjustments.

- Clean valve rocker arm cover(s) and cylinder head sealing surface(s). Position seal in cover seal groove, making sure that the seal tang is aligned with notch in the cover.
- Position cover(s) on the cylinder head(s). Tighten the four rocker arm cover bolt and washer assemblies to 12-15 N·m (9-11 ft-lb) from right-to-left.
- 6. Install PCV valve (RH cover).
- 7. Install ignition coil mounting bracket. Connect spark plug wires to spark plugs:
- Connect thermactor air control valve and bracket assembly.
- Install thermactor air supply tube and MTA hose at thermactor valve.
- 10. Install air cleaner and intake duct assembly.
- 11. Connect battery(s).
- 12. Start engine and check for leaks.

# Valve Rocker Arm and Hydraulic Lash Adjuster Removal

- Remove the valve rocker arm cover, lower intake manifold, rocker arm fulcrum assembly, push rod, and associated parts as required.
- Lift out the hydraulic lash adjuster.

#### Installation

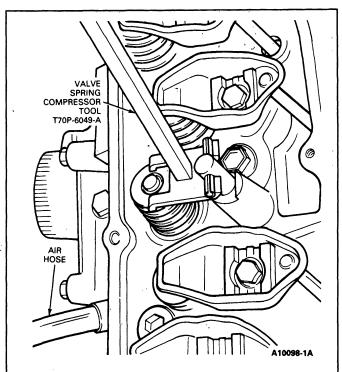
- Place the hydraulic lash adjuster in position in the bore.
- Install lower intake manifold gaskets and seals. Install lower intake manifold, rocker arm fulcrum assembly, push rod, and associated parts as required.
- Clean the sealing surfaces of the valve cover and cylinder head.
- Position seal in cover seal groove, making sure that the seal tang is aligned with notch in the cover.
- Position cover(s) on the cylinder head(s). Tighten the rocker arm cover bolt and washer assemblies to 8-12 N·m (6-9 ft-lb) from right-to-left.
- Install the air cleaner and all other hardware removed.
- 7. Run the engine at fast idle and check for oil leaks.

# Valve Spring, Retainer and Stem Seal

If the valve or valve seat has not been damaged, the valve spring damper assembly, seals and retainers may be replaced by holding the affected valve against its seat using compressed air. Use an appropriate air line tool installed in the spark plug hole. A minimum of 965 kPa (140 psi) line pressure is required. If air pressure does not hold the valve shut, the valve is damaged or burned and the cylinder head must be removed and serviced. Refer to Section 03-00, Engine, Gasoline—General Service.

# Removal

- Remove the valve rocker arm cover and associated parts as required.
- 2. Remove the rocker arm and fulcrum assembly.
- Using Valve Spring Compressor Lever T70P-6049-A or equivalent, compress the valve spring and remove the retainer locks, spring retainer, and spring. Remove and discard the stem seal.



- 4. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.
- 5. Inspect the valve stem for damage. Rotate the valve and check the stem tip for eccentric movement. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head and service. Refer to Section 03-00, Engine, Gasoline General Service.

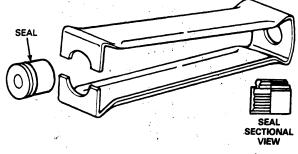
# Installation

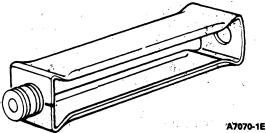
NOTE: Unique exhaust and intake guide mounted valve stem seals are required and care should be used to install the correct seal in the appropriate location. The seals are identified on one end with IN for intake and EX for exhaust.

- Install a new valve stem seal using a plastic installation cap using Valve Seal Installer T73P-6571-A or equivalent and the procedure given in the illustration. Install the valve spring retainer and locks. Turn off the air and remove the air line and adapter.
- Apply Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent to all contact surfaces of the cam follower. Install push rod, rocker arm and fulcrum assembly and the spark plug.

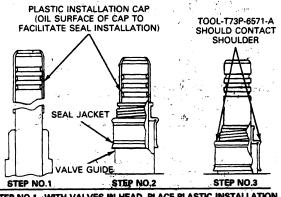
3 Install the rocker arm cover as outlined.

#### VALVE STEM INSTALLATION TOOL - T73P-6571-A





#### **VALVE STEM SEAL INSTALLATION**



STEP NO.1- WITH VALVES IN HEAD, PLACE PLASTIC INSTALLATION CAP OVER END OF VALVE STEM.

STEP NO.2- START VALVE STEM SEAL CAREFULLY OVER CAP. PUSH SEAL DOWN UNTIL JACKET TOUCHES TOP OF GUIDE.

STEP NO.3- REMOVE PLASTIC INSTALLATION CAP. USE INSTALLATION TOOL-T73P-6571-A OR SCREWDRIVERS TO BOTTOM SEAL ON VALVE GUIDE.

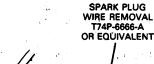
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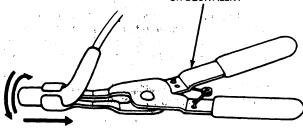
#### Intake Manifold

# Removal

- 1. Disconnect battery(s).
- Drain cooling system. Remove air cleaner and intake duct assembly.
- Remove Thermactor system from right-hand side 3. of engine.
- 4 Remove ignition coil mounting bracket from LH and RH sides of engine and remove high tension lead at the coil.

- 5. Disconnect and remove external EGR tube.
- 6. Disconnect upper radiator hose at engine.
- 7. Disconnect heater hoses at intake manifold and water pump. Loosen water bypass hose at intake manifold.
- 8. Disconnect PCV valve and hose (RH cover). Disconnect all the vacuum lines at rear of intake manifold and tag them for reference during installation.
- Disconnect wires at the spark plugs using Spark Plug Wire Remover T74P-6666-A or equivalent and move out of the way. Disconnect and remove the distributor cap and wires as an assembly.





TWIST AND PULL

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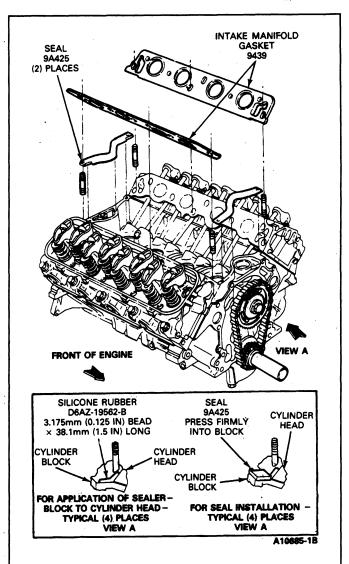
- Remove distributor, Refer to Section 03-07. Ignition System General Service for breakerless ignition systems.
- 11. Disconnect accelerator linkage and transmission kickdown linkage at the throttle body. Remove speed control linkage bracket, if so equipped, from the intake manifold and disconnect it from the throttle body. Remove bolts holding accelerator linkage cable, and position linkage out of way.
- 12. Disconnect fuel lines at fuel rail.
- 13. Disconnect wiring harness from main wiring harness. Wiring harness and lower intake manifold to be removed as an assembly.
- 14. Remove attaching bolts. Remove intake manifold and throttle body as an assembly using engine lifting eyes. If necessary to pry manifold away from the cylinder heads, do not damage the gasket sealing surfaces.
- 15. Remove and discard intake manifold gaskets and seals.
- 16. If manifold is to be further disassembled refer to Section 03-04C, Fuel Charging and Controls—7.5L Engine.
- 17. Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

18. Inspect the manifold for cracks, damaged gasket surfaces, or other wear or damage that would make it unfit for further service. Replace all fasteners that are stripped or otherwise damaged. Remove all filings and foreign matter that may have entered the manifold as a result of repairs.

# Installation

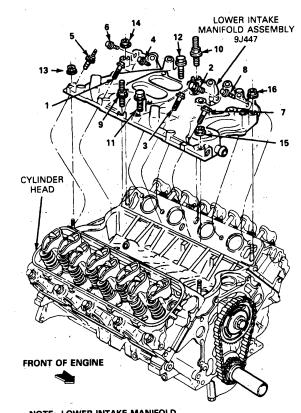
- Clean mating surfaces of intake manifold, cylinder heads, and cylinder block. Use a solvent such as Ford Spot Remover B7A-19521-A (ESR-M5B197-A) or equivalent degreasing agent.
- Apply a 3.2mm (1/8-inch) diameter bead of sealer, in and along the joint, the full width of the cylinder block seal mounting surface (four corners) as shown.
- Install the intake manifold gasket and the front and rear intake manifold to cylinder block seals.
   Apply a 1.6mm (1/16-inch) bead of sealer at the outer end of each intake manifold seal for the full width of the seal.

NOTE: This sealer sets up within 15 minutes after application. Assemble promptly.



4. Carefully lower intake manifold into position over four studs in ends of cylinder heads. When intake manifold is in place, run finger around seal area to ensure seals are in place. If seals have shifted, remove manifold and re-position seals.

 Ensure intake manifold gaskets are properly aligned. Then, install attaching bolts and stud bolts into holes 1 through 10.



NOTE: LOWER INTAKE MANIFOLD ASSEMBLY SHOWN SIMPLIFIED TO CLARIFY INSTALLATION

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- 6. Install bolts into holes 11 and 12.
- 7. The lower intake manifold fasteners are secured following a three step rundown procedure (as outlined in steps 8 through 10).
- Install nuts onto studs 13 through 16. Tighten bolts 1 through 12 in sequence to 11-16 N·m (8-12 ft-lb). Tighten nuts 13 through 16 in sequence to 11-16 N·m (8-12 ft-lb).
- 9. Tighten bolts and nuts 1 through 16 in sequence to 16-30 N·m (12-22 ft-lb).
- 10. Tighten manifold bolts and nuts 1 through 16 in sequence to 30-47 N·m (22-35 ft-lb).
- Install external EGR tube and thermactor exhaust air supply tubes.
- 12. Install water pump bypass hose to intake manifold fitting and heater hot water tube.
- 13. Connect radiator upper hose to coolant outlet housing.

- 14. Rotate crankshaft damper until No. 1 piston is at TDC at end of compression stroke. Install the distributor. Refer to Section 03-07, Ignition System General Service for breakerless ignition systems.
- 15. Connect heater hoses at intake manifold and water pump.
- Install accessory drive belts and tighten to specification.
- Connect PCV valve and hose to RH valve rocker arm cover.
- 18. Connect fuel lines to fuel rail.
- Install ignition coil mounting brackets on LH and RH sides of engine.
- 20. Complete all electrical connections.
- Position accelerator linkage on manifold. Attach accelerator linkage cable. Attach speed control linkage bracket to intake manifold, if so equipped. Install accelerator and kickdown linkage to throttle body.
- Connect the vacuum lines to their respective ports at rear of intake manifold.
- Secure distributor cap to distributor. Connect spark plug wires to spark plugs. Connect coil high tension lead to coil.
- 24. Fill and bleed the cooling system. Refer to Section 03-03, Cooling System Service.
- 25. Connect the battery(s).
- 26. Start engine. Check and adjust ignition timing, if necessary. Connect distributor vacuum lines.
- Operate engine at fast idle and check for coolant leaks. Check coolant level and refill as necessary.
- Start the engine and allow it to reach normal operating temperature. Then, while hot, tighten the manifold attaching nuts and bolts to 30-47 N-m (22-35 ft-lb).
- 29. Install air cleaner and intake duct assembly.

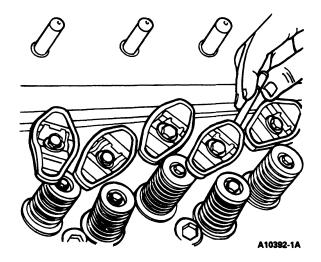
# Valve Tappet

The following procedure is applicable for removing one or all of the valve tappets. Before replacing a hydraulic valve tappet for noisy operation, ensure the noise is not caused by improper valve clearance or by worn rocker arms and/or push rods.

## Removal

1. Remove intake manifold as outlined.

Remove the valve rocker arm covers. Loosen the rocker arm fulcrum bolts and turn rocker arms to one side.



- 3. Remove the push rods in sequence.
- 4. Remove the valve tappets with a magnet. Place them in a rack in sequence. If the tappets are stuck in bores, use Hydraulic Lifter Puller T70L-6500-A or equivalent to remove them. Rotate tappets back and forth to loosen them from gum or varnish deposits.

Refer to Section 03-00, Engine, Gasoline—General Service for cleaning, inspection and testing procedure. If necessary to disassemble tappet(s), refer to Valve Tappet Disassembly and Assembly.

#### Installation

- Clean the outside of valve tappets. Tappets and bores are to be lubricated with recommended engine oil before installation. Install the tappets into their original bores. Check any new tappet for free fit in bore to which it is to be installed. Prior to installation of a new lifter, ensure lifter is full of oil by working the valve tappet plunger up and down until the tappet fills with fluid and all traces of air bubbles has disappeared.
- Install push rods in original positions. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips and push rod ends.
- Position the rocker arms over the push rods.
   Tighten the bolts following the procedure under
   Valve Rocker Arm Installation. Adjust valve
   clearance as outlined.
- Install rocker arm covers following procedure under Rocker Arm and Cover Installation.
- Install intake manifold and throttle body following the instructions under Intake Manifold.

# Cylinder Heads

#### Removal

- 1. Drain cooling system.
- Remove lower intake manifold and upper as an assembly following procedure under Intake Manifold Removal.
- Disconnect muffler inlet pipe at exhaust manifold.
- Remove power steering and alternator drive belts.
- 5. Remove Thermactor air pump and alternator.
- Remove the Thermactor air pump bracket from the RH head.
- If equipped with air conditioning, shut off compressor at service valves and remove valves and hoses from compressor. Remove nuts attaching compressor support bracket to water pump. Remove bolts attaching compressor to upper mounting bracket and position compressor out of the way. Remove compressor and power steering pump mounting bracket from cylinder head and water pump. Refer to Section 12-03B, A/C—Heater System—Econoline.

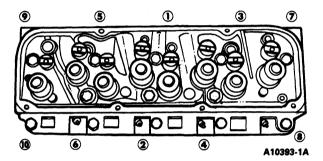
If not equipped with air conditioning, remove bolts attaching power steering pump bracket to LH cylinder head. Position pump and bracket out of the way.

- 8. Disconnect the oil filler tube (E-Series and Motor Home Chassis).
- Remove valve rocker arm covers. Remove rocker arm fulcrum bolts, rocker arms, oil deflectors, fulcrums and push rods in sequence so they can be installed in their original positions.
- 10. Remove cylinder head attaching bolts. Lift cylinder heads and exhaust manifolds as assemblies from cylinder block with a hoist. If necessary to loosen cylinder head gasket seal, pry at forward corners of cylinder heads against casting bosses provided on cylinder block. Do not damage machined surfaces of head or block. Discard cylinder head gasket.
- 11. If disassembly or machining of cylinder head is required, remove exhaust manifold.

#### Installation

 Clean cylinder head, intake manifold, valve rocker arm cover, and cylinder block sealing surfaces. If cylinder head was removed for cylinder head gasket replacement, check flatness of cylinder head and block gasket surfaces. If exhaust manifold was removed, coat cylinder head and manifold port areas with film of graphite grease and install manifold to cylinder head.

- Place two long cylinder head attaching bolts in two rear lower bolt holes of LH cylinder head.
   Place a long cylinder head attaching bolt in rear lower bolt hole of RH cylinder head. Use rubber bands to retain bolts in position, above head-to-block mating surface, until cylinder heads are installed.
- 3. Position new cylinder head gaskets on block over dowels. Do not apply sealer to head gasket surfaces. Place cylinder heads on block, guiding exhaust manifold studs into muffler inlet pipe connections. Install remaining attaching bolts (longer bolts in lower row of bolt holes). Tighten all cylinder head attaching bolts in sequence in three steps: first to 108-122 N·m (80-90 ft-lb), then to 136-149 N·m (100-110 ft-lb), and finally to 177-189 N·m (130-140 ft-lb). When this procedure is used, it is not necessary to tighten bolts after extended operation.



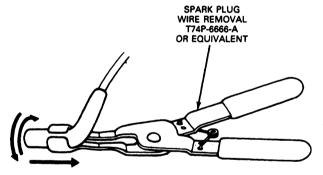
- Clean and inspect push rods, one at a time. Clean the oil passage in the push rods with a suitable solvent, and blow out with compressed air.
- Install push rods in original positions. Apply Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips and push rod ends.
- Lubricate and install the rocker arms following the procedure under Valve Rocker Arm Installation.
   Ensure lower ends of push rods remain seated in valve tappets.
- 7. Tighten muffler inlet pipe stud nuts to 34-52 N-m (25-38 ft-lb).
- Install intake manifold and carburetor assembly following procedure under Intake Manifold Installation.
- 9. Perform Valve Clearance Check, as outlined.
- If equipped with air conditioning, install compressor mounting bracket, with power steering pump in place, to LH cylinder head and water pump. Attach compressor to mounting bracket. Connect service valves and hoses to compressor.
  - If not equipped with air conditioning, attach power steering pump and bracket to LH cylinder head and water pump.
- 11. Connect oil filler tube (E-Series and Motor Home Chassis).

- Install Thermactor supply manifold to exhaust manifold.
- Install bolt attaching alternator and air pump bracket to RH cylinder head. Install air pump and alternator. Adjust alternator drive belt tension. Refer to Section 03-05, Engine Accessory Drive.
- Install air conditioning and power steering pump drive belt.
- 15. Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling. Fill and bleed power steering reservoir, as necessary.
- 16. Connect battery(s).
- 17. Start engine and check for leaks.
- If equipped with air conditioning, evacuate compressor and partially charge system with refrigerant. Refer to Section 12-03, Air Conditioning General Service.

#### **Exhaust Manifolds**

#### Removal

- If removing RH exhaust manifold, remove spark plug heat shield.
- 2. Remove spark plug wires using Spark Plug Wire Remover T74P-6666-A or equivalent.



TWIST AND PULL

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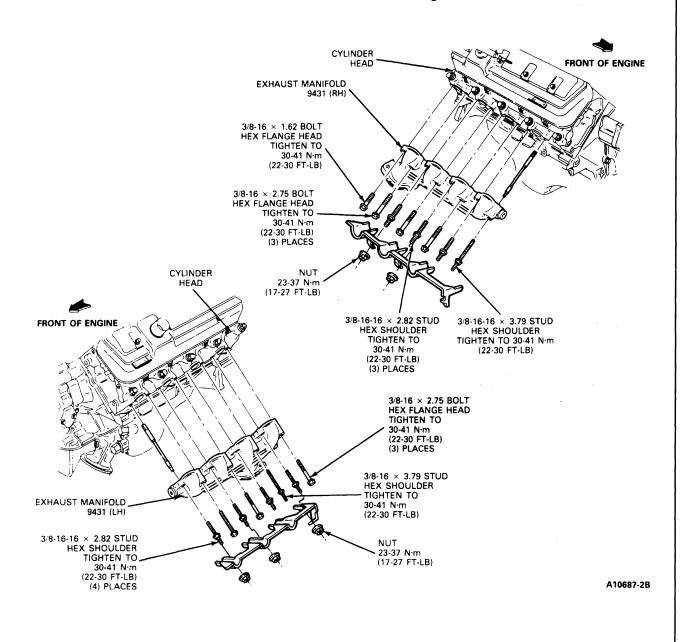
- Disconnect external EGR tube on LH exhaust manifold.
- 4. Disconnect exhaust manifold(s) at muffler inlet pipe(s).
- Remove power steering pump support bracket (on Econoline remove brace from back of power steering pump). Remove oil dipstick tube from LH exhaust manifold.
- Remove attaching bolts. Remove exhaust manifold(s).

Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

Inspect the manifold(s) for cracks, damaged sealing surfaces, or other wear or damage that would make them unfit for further service.

#### Installation

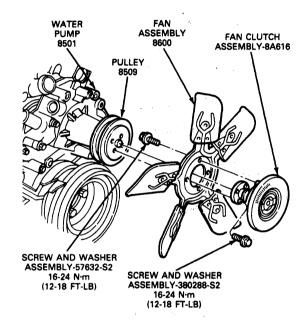
- Clean mating surfaces of exhaust manifold(s) and cylinder head(s). Clean mounting flange of manifold(s) and inlet pipe(s). Apply light film of graphite grease CIAZ-19590-BA (ESA-M1C75-B) to exhaust manifold(s).
- Position exhaust manifold(s) on cylinder head(s). Install attaching bolts and washers, starting at fourth bolt hole from front of each manifold. Tighten bolts to specifications working from center of manifold to both ends.
- Position inlet pipes to manifolds. Install attaching nuts and tighten to specification. Refer to Section 09-00, Exhaust System General Service.
- 4. Install heat shield and spark plug wires.
- Install air cleaner and intake duct assembly, if removed.
- 6. Start engine and check for exhaust leaks.



#### **Water Pump**

#### Removal

- Drain cooling system. Refer to Section 03-03, Cooling System Service. Remove the fan shroud attaching bolts.
- Remove bolts attaching fan assembly to water pumps and remove shroud and fan.



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- 3. Remove power steering drive belts.
- If vehicle is equipped with air conditioning, loosen compressor attaching bolts and remove. Remove air conditioner and power steering pump bracket.
- Loosen alternator bolts and remove alternator and air pump drive belt. Remove air pump and bracket.
- 6. Loosen the bypass hose clamp at the pump.
- Remove remaining water pump attaching bolts and remove water pump from cylinder front cover. Remove separator plate from water pump. Discard gaskets.

# Installation

- Remove any gasket material from water pump, cylinder front cover and separator plate mating surfaces.
- Position new gaskets coated on both sides with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent water-resistant sealer.
- Position water pump on cylinder front cover. Install bolts and tighten to 16-24 N·m (12-18 ft-lb).

- Install pulley on water pump. Position drive belts on their respective pulleys.
- Connect radiator block mounted oil cooler "jumper" hose, heater return hose, and bypass hose to water pump.
- Install air conditioner compressor bracket with power steering pump in place.
- Rotate the alternator and air pump bracket into position and install the attaching bolts. Install air pump and alternator.
- Lower the fan and radiator shroud into position. Refer to Section 03-03, Engine Cooling. Install the fan attaching bolts and the shroud attaching bolts. Tighten the bolts to 16-24 N·m (12-18 ft-lb).
- Adjust the alternator and air pump tension to specification. Refer to Section 03-05, Engine Accessory Drive.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling.
- 11. Start the engine and check for leaks.

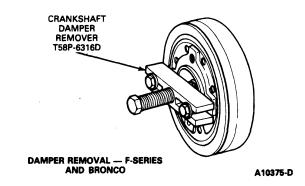
# Front Cover and Timing Chain

#### Removal

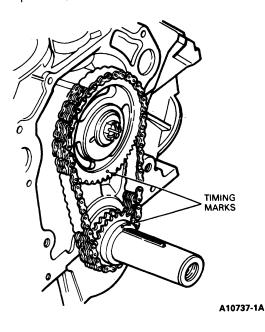
Cylinder front cover oil seal replacement is recommended whenever the cover has been removed.

- 1. Disconnect battery(s).
- 2. Drain cooling system and crankcase. Refer to Section 03-03, Engine Cooling.
- Remove screws attaching radiator shroud to radiator. Remove bolts attaching fan to water pump shaft as outlined. Remove fan and radiator shroud.
- Disconnect radiator upper and lower hoses at engine. Disconnect transmission and engine oil cooler lines at radiator, if so equipped. Disconnect engine oil cooler from radiator support and position out of the way.
- Remove radiator upper support and remove radiator. Refer to Section 03-03, Engine Cooling.
- 6. Position alternator splash shield out of the way.
- Loosen alternator attaching bolts to relieve tension on drive belt. Remove front end accessory drive hardware as outlined. Remove drive belts with water pump pulley.
- Remove alternator, air pump and A/C compressor, if so equipped, and their respective brackets.
- Remove the crankshaft pulley from the vibration damper.

 Remove bolt and washer attaching crankshaft damper. Remove crankshaft damper using Crankshaft Damper Remover T58P-6316-D, or D80L-522-A or equivalent. Remove Woodruff key from crankshaft.

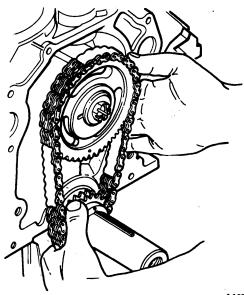


- 11. Loosen bypass hose at water pump. Disconnect heater return tube at water pump.
- 12. Remove bolts attaching front cover to cylinder block. Remove front cover and water pump as an assembly. Discard front cover gasket and oil pan seal. Using a thin-blade knife, cut the oil pan seal flush with cylinder block face separating the cover from the cylinder block.
- If new front cover is to be installed, remove water pump and install it and a new gasket on the new front cover.
- 14. Check timing chain deflection. Refer to Section 03-00, Engine, Gasoline—General Service.
- If the timing chain and sprocket are to be removed, crank the engine until timing marks on sprockets are as shown.



 Remove camshaft sprocket capscrew and washer. Slide timing chain and sprockets forward, and remove as an assembly.

> Refer to Section 03-00, Engine, Gasoline—General Service for cleaning and inspection procedures.

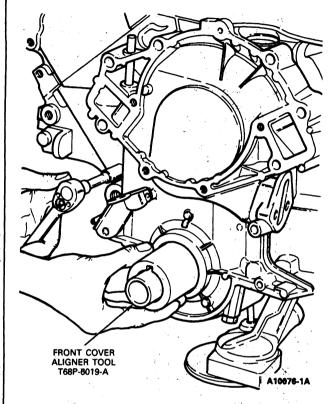


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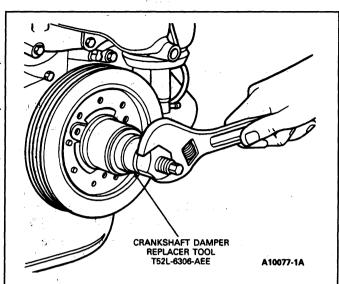
#### Installation

- Assemble the timing chain and sprockets so sprocket timing marks align with each other as shown under Removal. Install the chain and sprockets as an assembly to crankshaft and camshaft. Verify proper alignment of timing marks after installation. Install front oil slinger.
- Install the camshaft sprocket capscrew and washer. Tighten capscrew to 55-61 N·m (40-45 ft-lb). Lubricate timing chain with recommended quality engine oil. If a new chain is to be installed, submerge chain in a container of recommended quality engine oil.
- Replace front oil seal using the procedure in this Section.
- Coat the gasket surfaces of the block and cover with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18PZ-A), or equivalent sealer, and position a new gasket on the block.
- Position the front cover onto the cylinder block. Use care when installing the cover to avoid seal damage or possible mislocation.

 Install the front cover-to-seal alignment tool into proper position. It may be necessary to force the cover downward in a manner to slightly compress the pan seal. This operation can be facilitated by using a suitable tool at the attaching bolt hole locations.



- Coat the threads of the attaching bolts with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent oil-resistant sealer and install the screws.
- While pushing in on Front Cover Aligner Tool T68P-6019-A or equivalent, tighten the oil pan-to-cover attaching bolts to 10-12 N·m (7-9 ft-lb). Remove alignment tool. Tighten the cover-to-cylinder block attaching screws to 17-24 N·m (12-18 ft-lb).
- Apply white lead and oil mixture, Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to front of crankshaft for damper installation.
- Position crankshaft damper Woodruff key and install crankshaft damper using Crankshaft Damper and Sprocket Replacer T52L-6306-AEE or equivalent. Install damper attaching screw and washer. Tighten to 95-122 N·m (70-90 ft-lb).



- Install the crankshaft pulley and water pump pulley.
- 12. Install front end accessory drive hardware.
- 13. Install accessory drive belts and adjust belt tension to specifications. Refer to Section 03-05, Engine Accessory Drive. Tighten alternator attaching bolts and compressor idler pulley. Refer to Specifications.
- 14. Install alternator splash shield (Econoline only).
- Position radiator to lower support. Position upper support to radiator, and install attaching bolts. Connect radiator upper and lower hoses at engine. Connect transmission oil cooler lines. Refer to Section 03-03, Engine Cooling.
- 16. Place fan assembly inside radiator shroud and set in position in vehicle. Position the fan and fan spacer on the water pump pulley. Install and tighten the attaching bolts. Install screws attaching shroud to radiator.
- The crankcase oil should be drained and refilled with the proper grade and quantity of engine oil before starting the engine.
- 18. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase to the correct level with the recommended oil.
- Connect battery(s).
- Run engine at fast idle and check for coolant and oil leaks. Adjust ignition timing to specification listed on the Vehicle Emission Control Information (VECI) decal.

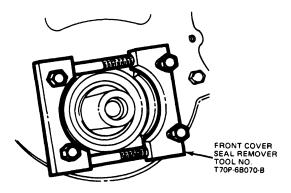
#### **Front Oil Seal**

Replacement of the front oil seal is recommended whenever the front cover is removed.

#### Removal

 Remove the bolts attaching the fan shroud to the radiator.

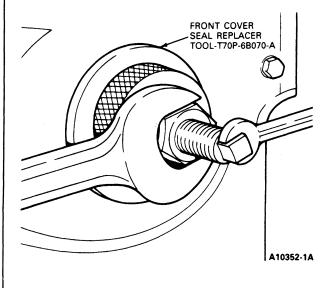
- 2. Remove the fan bolts from the water pump shaft. Remove the fan, spacer and shroud.
- Remove the alternator, power steering, Thermactor and air conditioner drive belts.
- Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper and remove the vibration damper.
- Place the Front Cover Seal Replacer
  T70P-6B070-B or equivalent onto the front cover
  plate over the front seal. Tighten the two through
  bolts to force the seal puller under the seal flange.
- Alternately tighten the four puller bolts one half turn at a time. Pull the oil seal from the front cover.



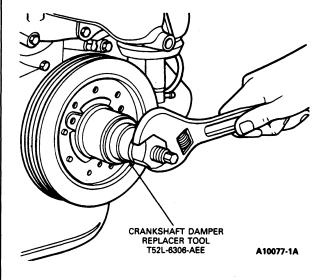
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#### Installation

 Coat a new front cover plate oil seal with Lubriplate or equivalent and place it onto the Front Cover Seal Replacer T70P-6B070-A. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.

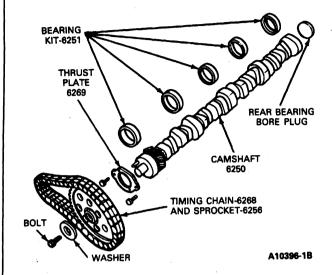


- Place the installation screw, washer, and nut onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.
- Apply Lubriplate or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.
- 4. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on crankshaft using Crankshaft Damper and Sprocket Replacer T5ZL-6306-AEE, or equivalent. Install the capscrew and washer. Tighten the screw to 95-122 N·m (70-90 ft-lb). Install the crankshaft pulley.
- Install the alternator and power steering pump belts.
- Position the fan shroud over the water pump pulley. Install the fan. Install the fan shroud attaching screws.
- 7. Adjust the drive belts to specification. Refer to Section 03-05, Engine Accessory Drive.



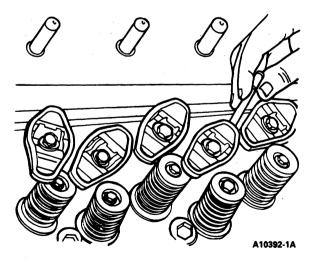
#### Camshaft

Refer to the illustration for the camshaft and related parts.



#### Removal

- Remove cylinder front cover, timing chain and sprockets following procedure under Front Cover and Timing Chain. Check timing chain deflection before removal. Refer to Section 03-00, Engine, Gasoline—General Service.
- Remove the intake manifold and throttle body as an assembly as outlined under Intake Manifold, Removal.
- Remove valve rocker arm covers. Back off all rocker arm fulcrum bolts, turn rocker arms sideways, and remove the push rods in sequence.



- 4. Remove the valve tappets with a magnet and place them in a rack in sequence. If the tappets are stuck in bores, use Hydraulic Lifter Puller Tool T70L-6500-A or equivalent to remove them. Rotate the tappets back and forth to loosen them from gum or varnish deposits.
- Remove the bolts—taching the air conditioning condenser to the chassis, if so equipped.
   Carefully rest the condenser on the LH fender.
   Secure it in this position. Refer to Section 12-03B, A/C—Heater System—Econoline.
- 6. Remove the grille.
- Remove the camshaft thrust plate attaching bolts, and carefully remove the camshaft from the front of engine. Do not damage the camshaft bearings by nicking them with the cam lobes.

Refer to Section 03-00, Engine, Gasoline—General Service for cleaning and inspection procedures, and repair as required.

#### Installation

- Oil the camshaft journals and apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the cam lobes. Carefully slide camshaft into position.
- Install camshaft thrust plate. Check camshaft end play following procedure in Section 03-00, Engine, Gasoline—General Service. If end play is excessive, replace the camshaft thrust plate.
- Install timing chain, sprockets, oil slinger and front cover as detailed under Front Cover and Timing Chain.
- Position the radiator in the vehicle and install the radiator upper support to secure radiator. Refer to Section 03-03, Engine Cooling. Connect the radiator lower hose and oil cooler lines.
- Install the grille center support and air conditioning condenser. Refer to Section 12-03B, A/C—Heater System—Econoline.
- Clean the tappets externally. Lubricate the tappets and tappet bores with specified engine oil before installing them. Lubricate the push rod ends with Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent. Install the valve tappets and push rods in their original positions.
- Install intake manifold and throttle body following the procedure under Intake Manifold, Installation.
- Rotate the crankshaft damper until No. 1 piston is at TDC at the end of compression stroke. Install the distributor following the procedure in Section 03-07, Ignition System General Service for breakerless ignition systems.

- Apply Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips. Position rocker arms over push rods and tighten bolts following the procedure under Valve Rocker Arm Installation. Adjust valve clearance if necessary as outlined.
- Clean the valve rocker arm covers and cylinder head sealing surfaces. Position new seal, if required, in cover seal groove. Ensure that the seal tang is secured in the notch of the cover.
- 11. Position cover on the cylinder head and tighten the four rocker arm cover bolt and washer assemblies to 8-12 N·m (6-9 ft-lb) as outlined.
- 12. Connect the radiator upper hose. Connect heater hose at intake manifold and at water pump.
- Install the accelerator linkage. Install the speed control linkage, if so equipped.
- Connect engine vacuum lines to their original outlets on the fitting at rear of the intake manifold. Connect PCV valve and hose to right valve rocker arm cover.
- Install the distributor cap and connect the coil and spark plug wires.
- 16. Place the fan assembly in the radiator shroud and set in position. Position the fan assembly and fan spacer, if so equipped, to water pump hub. Install and tighten the attaching screws to specification. Install screws attaching shroud to the radiator.
- 17. Place the water pump pulley and drive belts in position on the water pump hub. Adjust the tension of drive belts. Refer to Section 03-05, Engine Accessory Drive. Tighten attaching screws. Refer to Specifications.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill and bleed power steering reservoir. Run engine at fast idle and check for leaks.
- Adjust the ignition timing to specifications listed on the engine decal and connect distributor vacuum line.
- Adjust transmission linkage, if necessary. Refer to Section 07-00A or 07-00B. Install the air cleaner and intake duct.

# **Flywheel**

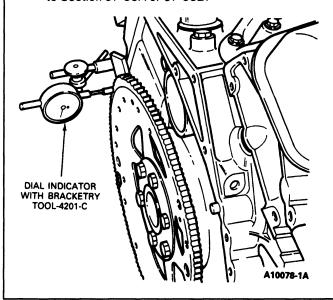
#### Removal

 Remove the transmission from vehicle. Refer to Section 07-00A or 07-00B. Remove the mounting flywheel bolts and remove flywheel from the crankshaft.

Refer to Section 03-00, Engine, Gasoline—General Service for inspection.

#### Installation

- Install flywheel on crankshaft. Install the mounting bolts. Tighten to 103-115 N·m (75-85 ft-lb).
- Check flywheel runout and ring gear runout using Dial Indicator With Bracketry TOOL-4201-C or equivalent. Refer to Section 03-00, Engine, Gasoline—General Service. Refer to Specifications at the end of this section.
- Install transmission assembly into vehicle. Refer to Section 07-00A or 07-00B.



# Camshaft Rear Bearing Bore Plug

#### Removal

- Remove the transmission from the vehicle. Refer to Section 07-00A or 07-00B.
- Remove flywheel and engine rear cover plate following procedure under Flywheel Removal.
- Replace the plug. Refer to Section 03-00, Engine, Gasoline—General Service.

#### Installation

- Install the engine rear cover plate and flywheel following procedure under Flywheel Installation.
- Install the transmission. Refer to Section 07-00A or 07-00B.

#### Oil Pan

#### Removal

 Remove the engine cover, disconnect the battery, and drain the cooling system. Refer to Section 03-03, Engine Cooling.

- Disconnect the fresh air inlet tube and remove the air cleaner assembly. Disconnect the throttle and transmission linkage at the throttle body.
   Disconnect the power brake vacuum line.
- Disconnect the fuel lines at the fuel rail, and disconnect air tubes at the throttle body.
- Disconnect the radiator upper and lower hoses.
- 5. Disconnect the two transmission oil cooler lines at the radiator. Disconnect engine oil cooler lines at the filter adapter, if so equipped. Remove the fan assembly and shroud, and remove the radiator (bolts). Refer to Section 03-03, Engine Cooling. Remove the power steering pump and position out of the way.
- Remove the front engine mount attaching through bolts. Remove the nuts attaching the oil dipstick tube to the exhaust manifold.
- 7. Remove the oil filler tube and bracket (bolt).
- If so equipped, rotate A/C lines (at rear of compressor) down to clear the dash. Remove the A/C lines if necessary.
- Remove the upper intake manifold and throttle body as an assembly.
- Raise the vehicle on a hoist, drain the crankcase, and remove the oil filter.
- Remove the muffler inlet pipe assembly.
   Disconnect the manual and kickdown linkage from the transmission.
- Remove the drive shaft and coupling shaft assembly. Remove the transmission dipstick tube assembly.
- 13. Remove the dipstick and tube from the oil pan. Place a transmission jack under the engine oil pan. Insert a wood block between the jack surface and the oil pan. Jack the engine upward, pivoting about the rear mount until the transmission contacts the floor. Then, block the engine in position at the engine mounts. The engine must remain centralized to obtain the maximum height. The engine must be raised 102mm (four inches) at the mounts to remove the oil pan.
- 14. Remove the oil pan retaining bolts. Lower the oil pan. Remove the oil pump and pickup tube attachments. Drop the oil pump and pickup tube assembly into the oil pan. Remove the oil pan rearward from the vehicle.

#### Installation

 Clean the oil pan gasket surface at the cylinder block. Clean the oil pan assembly, the oil pump pickup tube, and the screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.

- Lightly apply Gasket and Trim Adhesive D7AZ-19B508-AA to the cylinder block surface. Position the one-piece silicone gasket to the cylinder block and press lightly until gasket sticks to surface. Position the oil pan with oil pump and pickup tube assembly to the chassis. Install the oil pump assembly to the cylinder block.
- Position the oil pan to the cylinder block and install the attaching bolts.
- Place jack under engine and raise engine enough to remove blocks.
- 5. Lower engine and remove jack.
- Position the engine oil dipstick tube to the oil pan and exhaust manifold and install the attaching nut.
- 7. Re-position the A/C lines, if so equipped.
- Install the engine support-to-bracket attaching through bolts and connect the manual kick-down linkage at the transmission. Install the drive shaft and coupling shaft assembly, and the muffler inlet pipe assembly.
- Clean the oil filter mounting surface and install the oil filter.
- Lower the vehicle from the hoist. Install the engine oil filler tube and bracket (one bolt). Attach the oil dipstick tube to the LH exhaust manifold (one nut).
- Install the radiator assembly and connect the two transmission oil cooler lines. Refer to Section 03-03, Engine Cooling.
- Install the fan assembly and shroud, and then connect the lower and upper radiator hoses.
- 13. Install the upper intake manifold and throttle body.
- Connect the throttle and transmission linkage at the throttle body.
- Re-position the power steering pump belt and adjust tension. Refer to Section 03-05, Engine Accessory Drive. Install the transmission filler tube to the RH cylinder head (two bolts).
- 16. Install the air cleaner assembly and fresh air inlet tube, fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Connect the battery and fill the crankcase. Start the engine and check for leaks. Install the engine cover.

#### Oil Pump

Remove and install the oil pump as outlined under Oil Pan Removal and Installation. The oil pump and oil pan must be removed together.

#### Crankshaft Rear Oil Seal

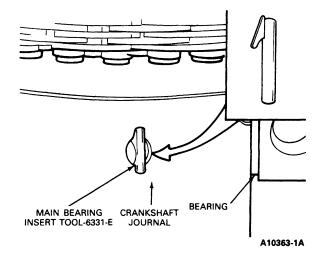
Replacement of a crankshaft rear oil seal (due to oil leakage) requires replacement of upper and lower seals. Refer to Section 03-00, Gasoline Engine General Service.

#### **Main Bearing**

Main and connecting rod bearing inserts are selective fits. Refer to Section 03-00, Gasoline Engine General Service.

#### Removal

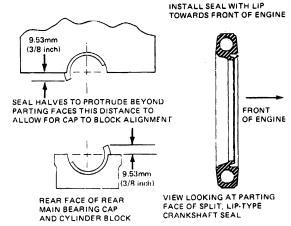
- Drain the crankcase. Remove the oil level dipstick. Remove the oil pan, oil pump and related parts following the procedure under Oil Pan Removal.
- Replace one bearing at a time, leaving other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.
- 3. Insert Main Bearing Insert TOOL-6331-E or equivalent in oil hole in crankshaft.
- 4. Rotate the crankshaft in the direction of engine rotation to force bearing out of block.
- Clean the crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear.



#### Installation

 To install upper main bearing, place plain end of bearing over shaft on locking tang side of block and partially install bearing so Main Bearing Insert TOOL-6331-E or equivalent can be inserted into oil hole in crankshaft. With Main Bearing Insert TOOL-6331-E or equivalent in oil hole, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

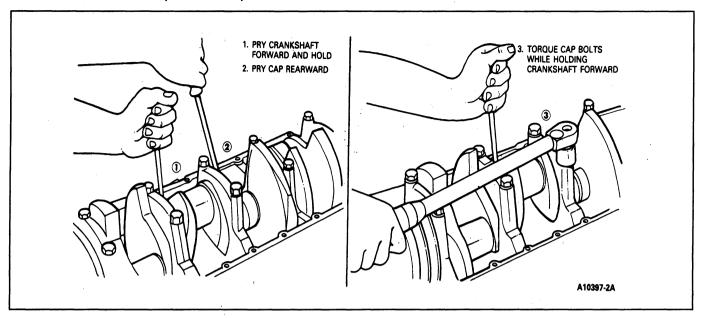
- 2. Fit the main bearings. Refer to Section 03-00, Engine, Gasoline—General Service under Fitting Bearings with Plastigage.
- After the bearing has been fitted, apply light coat of specified engine oil to journal and bearings. Install the bearing cap. Tighten the cap bolts to 129-142 N·m (95-105 ft-lb).
- Repeat the procedure for remaining bearings requiring replacement.
- If the rear main bearing is to be replaced, remove the rear main bearing cap. Remove and discard the rear oil seal.
- Clean rear journal oil seal groove and mating surfaces of block and rear main bearing cap.
- Install the new seal as shown, and according to procedure as outlined in Section 03-00, Engine, Gasoline—General Service.



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- Refer to Section 03-00, Engine, Gasoline—General Service for procedure used in sealing the rear main bearing cap. After sealing, install the rear main bearing cap. Tighten cap bolts 129-142 N·m (95-105 ft-lb).
- 9. If thrust bearing cap (No. 3 main bearing) has been removed, install as follows:

Install the thrust bearing cap with bolts finger-tight. Pry the crankshaft forward against the thrust surface of upper half of bearing. Hold the crankshaft forward and pry thrust bearing cap to rear. This aligns thrust surfaces of both halves of bearing. Retain forward pressure on crankshaft. Tighten cap bolts to 129-142 N·m (95-105 ft-lb).



- Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.
- Install the oil pan and oil pump following procedure under Oil Pan Installation.
- Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

### **Connecting Rod Bearing**

### Removal

- Drain the crankcase. Remove the oil level dipstick. Remove the oil pan, oil pump and related parts. Following the procedure under Oil Pan Removal.
- Turn the crankshaft until connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from rod and cap.
- Ensure bearing inserts and bearing bore in connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause a failure.
- Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance. Refer to Specifications.

### Installation

Refer to Section 03-00, Engine, Gasoline—General Service for cleaning and inspection procedures.

 Fit connecting rod bearings. Refer to Section 03-00, Gasoline Engine General Service under Fitting Bearings with Plastigage.

- 2. Install the bearing inserts in the connecting rod and cap with tangs in the slots provided.
- Pull the connecting rod assembly down firmly on the crankshaft journal (guide rod to prevent crankshaft journal damage).
- Apply a light coat of specified engine oil to the journal and bearings. Install the connecting rod cap. Ensure the connecting rod bolt heads are properly seated in the connecting rod. Tighten the nuts to 55-61 N·m (41-45 ft-lb).
- Repeat the procedure for the remaining connecting rods that require new bearings.
- To complete installation, follow instructions under Oil Pan Installation.

### Pistons and Connecting Rods

### Removal

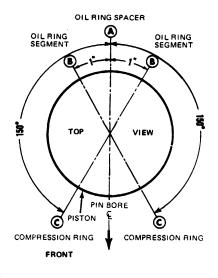
- Drain the cooling system and crankcase. Refer to Section 03-03, Engine Cooling. Remove the intake manifold, cylinder heads, oil pan and oil pump as outlined.
- Remove any ridge and / or deposits from upper end of cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at bottom of its travel. Place a cloth on top of the piston to collect cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore. Remove the cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer. Never cut into ring travel area in excess of 0.79mm (1/32 inch) when removing ridges. Repeat the procedure at the remaining cylinders. Refer to Section 03-00, Engine, Gasoline—General Service.

- 3. Ensure all connecting rod caps are marked so they can be installed in their original positions.
- Turn the crankshaft until the connecting rod being removed is down.
- 5. Remove the connecting rod nuts and cap.
- Push the connecting rod and piston assembly out through the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal and cylinder wall when removing the piston and rod.
- 7. Remove the bearing inserts from the connecting rod and cap.
- Install the cap on the connecting rod from which it was removed.

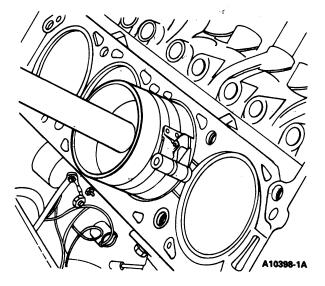
### Installation

- If new piston rings are to be installed, remove the cylinder wall glaze. Refer to Section 03-00, Engine, Gasoline—General Service. Clean cylinder bores with soap and water after honing or deglazing. Dry and oil immediately after cleaning.
- 2. Oil the piston rings, pistons and cylinder walls with recommended quality engine oil. Ensure to install pistons into cylinders from which they were removed or to which they were fitted. Connecting rod and bearing caps are numbered from 1 to 4 in the right bank, and 5 to 8 in the left bank, beginning at the front of engine. Numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.
- 3. Ensure ring gaps (oil ring spacer A, oil ring segments B, and compression ring C) are properly spaced around circumference of piston.



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- Turn the crankshaft until the piston rod journal reaches the bottom of its stroke.
- 5. Install Piston Ring Compressor, D81L-6002-C or equivalent, on piston and push in with hammer handle until it is slightly below top of cylinder. Ensure to guide connecting rods while tapping them into position to avoid damaging crankshaft journals. Install piston with indentation notch in piston head toward front of engine. Push the piston down into the cylinder until the connecting rod bearings seat on the crankshaft journal.



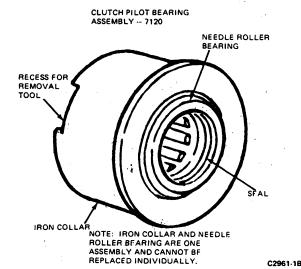
- Check clearance of each bearing. Refer to procedure under Fitting Connecting Rod Bearings in Section 03-00, Engine, Gasoline—General Service.
- After the bearings have been fitted, apply a light coat of recommended quality engine oil to the journals and bearings.
- Install the connecting rod cap. Ensure connecting rod bolt heads are properly seated in the connecting rod. Tighten the nuts to 55-61 N·m (41-45 ft-lb).
- After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each crankshaft journal. Refer to Section 03-00, Engine, Gasoline—General Service.
- Disassemble, clean and assemble the oil pump. Clean the oil pump inlet tube screen, oil pan, and the block gasket surfaces.
- 11. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and the oil pan following the procedure under Oil Pan Installation.
- 12. Install the cylinder heads following instructions under Cylinder Head Installation.

- Install the intake manifold following instructions under Intake Manifold Installation.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase to the correct level with the specified engine oil.
- Start the engine and adjust the ignition timing to specifications listed on the engine decal. Connect the distributor vacuum line.
- Operate the engine at fast idle and check for oil and coolant leaks after the engine temperature has stabilized.
- 17. Install the air cleaner and intake duct assembly.

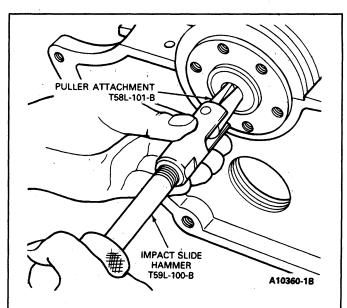
### **Clutch Pilot Bearing**

### Removal

A needle roller bearing and adapter assembly is used as a clutch pilot bearing on F-150—F-350, F-Super Duty and Bronco vehicles. It is inserted directly into the engine crankshaft. The bearing and adapter assembly comprises an assembly that cannot be serviced separately. The assembly must also be replaced as a unit. The clutch pilot bearing can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.



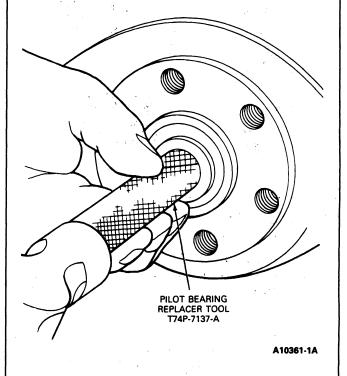
- Remove the transmission and flywheel housing, clutch pressure plate and disc. Refer to Group 16.
- Use Impact Slide Hammer T59L-100-B and Puller Attachment T58L-101-B or equivalent to remove the pilot bearing.



### Installation

- Using Pilot Bearing Replacer T74P-7137-A or equivalent, install the pilot bearing with the seal facing the transmission so that the adapter is not cocked.
- Install the clutch pressure plate, disc, and transmission and flywheel housing. Refer to Section 08-01, Clutch.

NOTE: Care must be taken not to damage the bearing during transmission installation while the transmission input shaft is being inserted into the bearing.



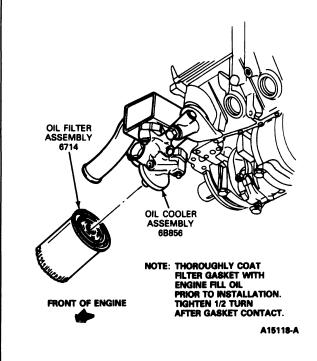
### Oil Filter

### Removal

 Place a drip pan under the filter. Unscrew the filter from the adapter fitting using an oil filter wrench. Clean the adapter recess. Clean the oil filter gasket surface.

### Installation

- Coat the gasket on a new filter with specified engine oil. Place a new filter on the adapter fitting. Hand tighten the filter until the gasket contacts the sealing surface, then tighten another one-half turn.
- Add one quart of oil. Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase to the correct level.



### REMOVAL AND INSTALLATION

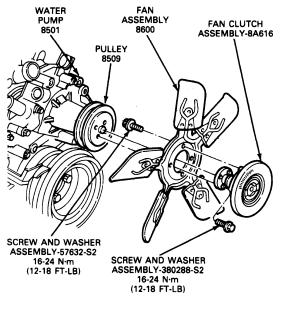
Engine-E-250-E-350

The engine removal and installation procedures are for the engine only (without the transmission attached).

### Removal

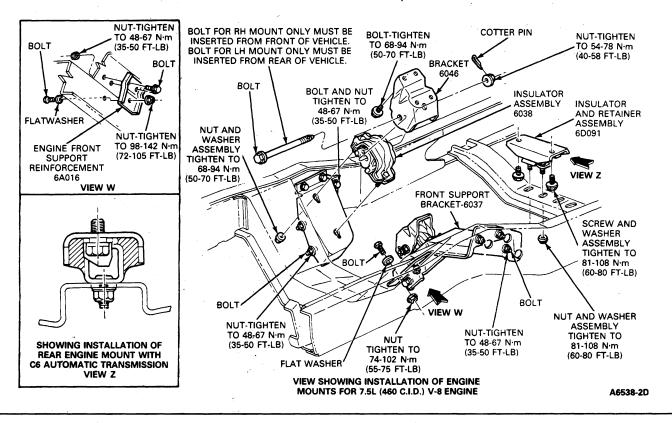
 Remove engine cover, open the hood disconnect battery, and drain cooling system. Refer to Section 03-03, Cooling System Service. Remove the grill assembly including gravel deflector.

- Remove four bolts that secure the air cleaner and bracket assembly at the body cowl and radiator support.
- 3. Disconnect the thermactor air pump inlet hose at the front of the air cleaner housing.
- 4. Disconnect the air outlet tube assembly at the throttle body and upper intake manifold. The air cleaner assembly and air outlet tubes can now be removed, after disconnecting the air inlet tube at the air cleaner.
- Remove the thermactor bypass valve hose connected to the air inlet tube and remove the air inlet tube.
- Remove the upper grille support bracket, hood lock support and condenser upper mounting brackets
- If so equipped, discharge the A/C system, and remove the A/C condenser. Refer to Section 12-03B, A/C—Heater System—Econoline. Disconnect the A/C lines at the compressor. Remove the accelerator cable bracket from the dash. Disconnect the two heater hoses from the engine.
- 8. Disconnect the upper and lower radiator hoses at the radiator.
- Remove the fan shroud and fan assembly. Remove the radiator from the vehicle. Refer to Section 03-03, Engine Cooling. Pivot the alternator inward. Disconnect the alternator lead wires at the alternator.



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- Disconnect throttle and transmission linkage at throttle body and remove accelerator cable bracket from upper intake manifold. Remove the speed control hardware if so equipped.
- 11. Disconnect the fuel lines at quick disconnect couplings and vacuum lines to the intake manifold. Disconnect EGR tube at LH exhaust manifold and upper intake manifold. Plug manifold opening. Refer to Group 03. Raise the vehicle on hoist, drain the crankcase, and remove the oil filter.
- Disconnect the muffler inlet pipe at the exhaust manifolds. Remove two bolts retaining the transmission filler tube bracket to the RH cylinder head.
- Disconnect exhaust air supply bypass valve hose at MTA check valve.
- Remove the engine mount attaching bolts and nuts. Remove the starter motor and disconnect the cable. Refer to Section 03-06A, Starter, Positive Engagement. Remove the converter inspection cover bolts.



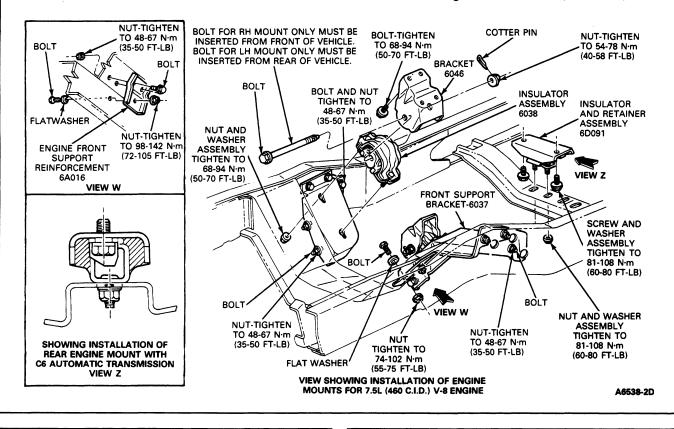
- Remove four nuts attaching the converter to the flex plate.
- Remove three bolts retaining the adapter plate to the converter housing.
- Remove four converter housing-to-cylinder block lower bolts. Remove the bolt attaching the ground cable to the cylinder block. Lower the vehicle on hoist.
- 18. Rotate the belt tensioner arm counterclockwise and remove the drive belt. Disconnect the A/C compressor, A/C lines and magnetic clutch lead wire, if so equipped. Disconnect power steering pump lines. Remove pump and bracket from front of engine.
- Disconnect any vacuum lines at the rear of the intake manifold. Disconnect the engine wire loom and position it out of the way.

- Position a floor jack under the transmission for support. Position a floor crane to the vehicle and connect it to existing lifting eyes.
- Remove two converter housing-to-cylinder block upper bolt and remove the engine from the vehicle.

### Installation

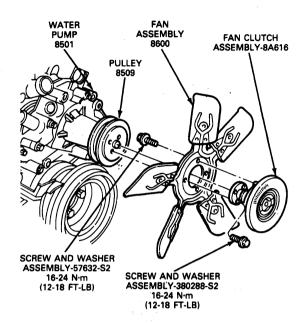
- Connect the floor crane to lifting eyes. Raise the engine and position it into the vehicle, aligning the transmission converter to the flywheel (or flex plate) and the engine dowels to the transmission. Lower the engine to the chassis brackets, and align the through bolt holes. Disconnect the floor crane and position it out of the way.
- Install two converter housing-to-cylinder block upper bolts. Remove the lifting bracket from the intake manifold (bolts).

- Remove floor jack from under the transmission, and position it out of the way.
- If so equipped, connect the A/C compressor magnetic clutch lead. Refer to Section 12-03B, A/C—Heater System—Econoline.
- Position the accelerator cable mounting bracket and the speed control servo to the intake manifold, and install attaching bolts.
- Position the engine wire harness in retainers and connect at respective locations. Connect vacuum lines at the rear of the intake manifold.
- Connect two heater hoses at water outlet connector and at water pump connector. Position the power steering bracket to the water pump and the LH cylinder head. Install the attaching bolts. Install the power steering pump to the bracket.
- Position the power steering pump drive belt to its respective pulleys, and install automatic belt tensioner. If so equipped, connect two A/C lines at the A/C compressor, and install the accelerator cable bracket to the dash. Refer to Section 12-03B, A/C—Heater System—Econoline.
- Raise the vehicle on a hoist. Install one bolt attaching battery ground cable to cylinder block. Install four lower converter housing-to-cylinder block lower bolts. Install the three adapter plate-to-converter housing bolts. Install four nuts attaching the converter to the flex plate. Install the converter inspection cover (bolts).
- Install the starter motor and connect the cable. Refer to Section 03-06A, Positive Engagement Starter. Install the engine mount attaching bolts and nuts. Tighten to 68-94 N·m (50-70 ft-lb).



- 11. Install the two bolts attaching the transmission filler tube bracket to the RH cylinder head.
- Connect the muffler inlet pipe at the exhaust manifolds. Install the oil filter.
- Lower the vehicle on hoist. Position the upper intake manifold and gasket onto the lower intake manifold, install four bolts and connect the fuel lines and vacuum lines. Refer to Section 03-04C, Fuel Charging and Controls—7.5L Engine.
- Connect the throttle and transmission linkage at the throttle body. Connect the alternator lead wires to the alternator.

Install the fan assembly to the water pump shaft and position the shroud over the fan assembly.



A10711-B

- 16. Position the radiator to the radiator support and secure with four attaching bolts. Refer to Section 03-03, Engine Cooling. Install the shroud and secure with four attaching bolts.
- Connect the radiator lower hose at the radiator. Connect the radiator upper hose at the radiator.
- 18. Install the A/C condenser-to-radiator support, if so equipped. Refer to Section 12-03B, A/C—Heater System—Econoline. Connect the speed control servo vacuum hose and secure the cable to the throttle body. Install the grille upper support bracket, hood lock support and condenser upper mounting brackets.
- 19. Install the grille assembly including gravel deflector. Fill the crankcase with specified type and quantity engine oil. Fill and bleed the cooling system. Adjust the tension of drive belt to specifications. Refer to Section 03-03, Engine Cooling and Section 03-05, Engine Accessory Drive.

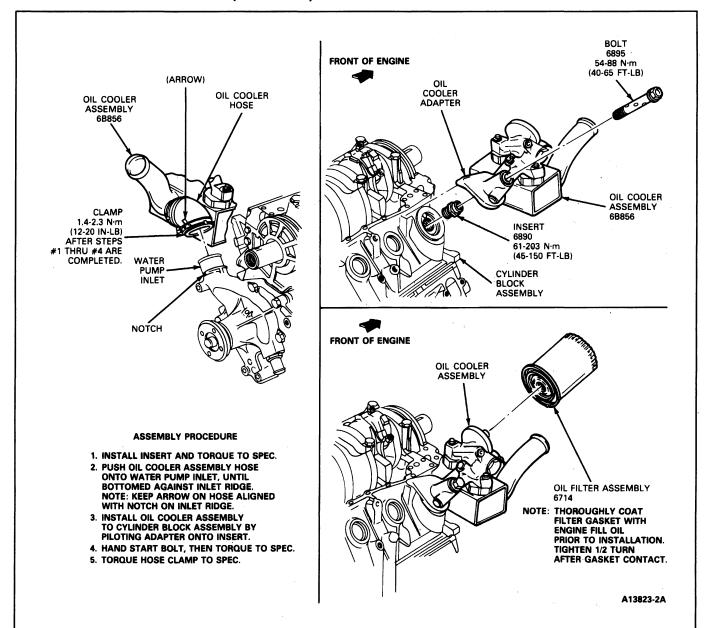
- Connect battery, start engine and check for leaks. Adjust idle speed to specifications on engine decal.
- Evacuate and charge the A/C system, if so equipped. Refer to Section 12-03, Air Conditioning, General Service. Install the air cleaner assembly.
- 22. Install the engine cover.

# Engine—F-250—F-350—F-Super Duty Chassis Cab and Motor Home Chassis

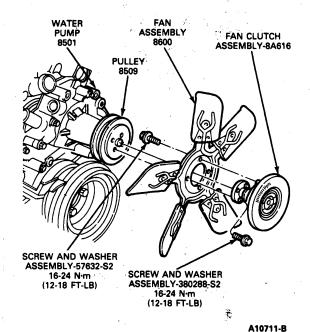
### Removal

- Drain the cooling system and the crankcase. Refer to Section 03-03, Engine Cooling. Remove hood. Refer to Section 01-02 Body Panels—Front End.
- 2. Disconnect the battery cables from the battery.
- 3. Disconnect the thermactor air pump inlet hose at the front of the air cleaner housing.
- Disconnect the air outlet tube assembly at the throttle body and upper intake manifold. The air cleaner assembly and air outlet tubes can now be removed, after disconnecting the air inlet tube at the air cleaner.
- Remove the thermactor bypass valve hose connected to the air inlet tube and remove the air inlet tube.
- Remove the air cleaner and intake duct assembly, including the crankcase ventilation hose and carbon canister hose.
- Disconnect the radiator lower and upper hose at the radiator. If equipped with an automatic transmission, disconnect the transmission oil cooler lines. If equipped with engine oil cooler, disconnect the cooler lines at the oil filter adapter.

CAUTION: Do not attempt to disconnect engine oil cooler lines at quick connect fittings behind or at the cooler on F-Series, or damage to fittings will occur.

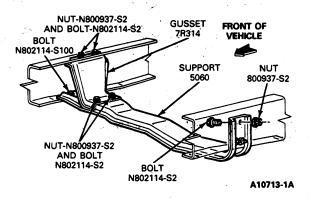


- If so equipped, discharge the A/C system and remove the A/C condenser. Refer to Section 12-03A, A/C—Heater System F-Series and Bronco. Disconnect A/C lines at the compressor.
- Remove the fan shroud and position it over the fan. Remove the radiator. Refer to Section 03-03, Engine Cooling. Remove the fan shroud, fan clutch, belts and pulley.



- Remove the alternator bolts and allow the alternator to swing down and out of the way.
- Disconnect throttle and transmission linkage at throttle body and remove accelerator cable bracket from upper intake manifold. Remove the speed control hardware if so equipped.
- Disconnect the oil pressure sending unit wire from the sending unit. Disconnect evaporative emission hoses at the evaporative canister.
- Disconnect the fuel lines at quick disconnect couplings and vacuum lines to the intake manifold.
- 14. Disconnect EGR tube at LH exhaust manifold and upper intake manifold. Plug manifold opening.
- Disconnect power brake booster vacuum hose, if so equipped.
- Disconnect the heater hoses from the water pump and intake manifold.

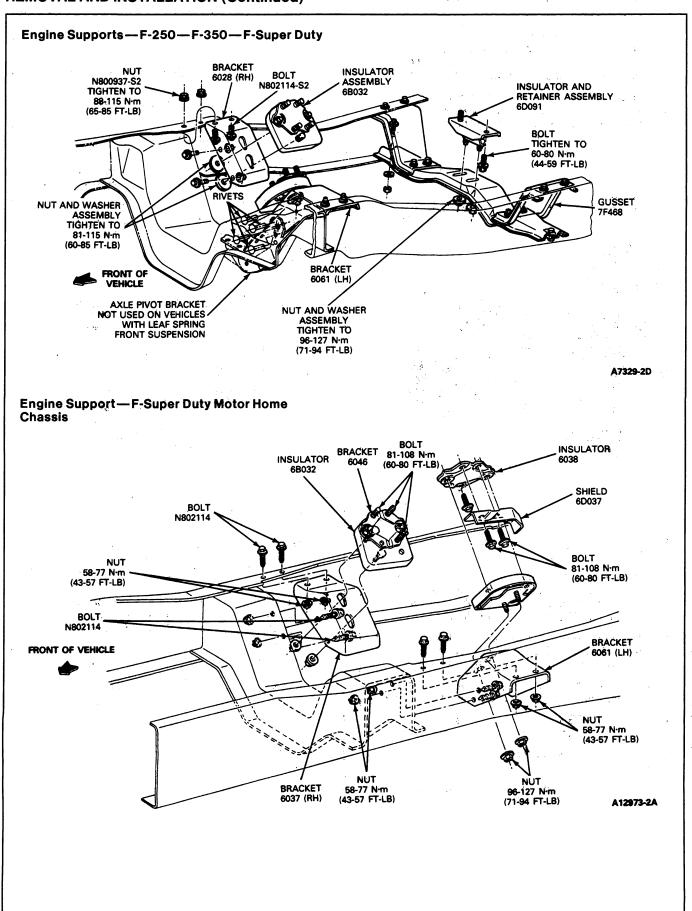
- Disconnect exhaust air supply bypass valve hose at MTA check valve.
- Remove the flywheel housing-to-engine upper holts.
- Disconnect the ground strap from the cylinder block.
- 20. Remove oil fill tube, dipstick and tube from engine.
- Raise the front of the vehicle. Disconnect the starter cable from the starter. Remove the starter. Refer to Section 03-06A, Starter, Positive Engagement.
- Disconnect the muffler inlet pipes from the exhaust manifolds. Disconnect the engine support insulators from the brackets on the frame underbody.



23. On a vehicle with automatic transmission, remove the converter inspection plate. Remove the torque converter to-flywheel attaching bolts.

On vehicles with manual transmission, remove the rear cover plate from the flywheel housing. Remove the remaining flywheel housing-to-engine bolts.

- If so equipped, disconnect A/C compressor magnetic clutch lead wire. Refer to Section 12-03A, A/C—Heater System F-Series and Bronco.
- 25. Lower the vehicle, and then support the transmission. Install Engine Lifting Brackets T70P-6000 or equivalent onto the intake manifold lifting eyes. Then, attach the engine lifting sling.
- 26. Raise the engine slightly and carefully pull it from the transmission. Carefully lift the engine out of the engine compartment so that the rear cover plate is not bent or other components damaged. Install the engine on a work stand.



### Installation

- Attach the engine lifting brackets and sling. Remove the engine from the work stand.
- Lower the engine carefully into the engine compartment. Ensure the dowels in the block are through the rear cover plate, then engage dowels with holes in the flywheel housing.

On a vehicle with manual transmission, start the transmission main drive shaft into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.

- 3. Install the flywheel housing upper bolts.
- Install the engine support and insulator-to-bracket nuts and washers. Tighten to 81-108 N·m (60-80 ft-lb). Disconnect the engine lifting sling.
- Raise the front of the vehicle. Connect both exhaust manifolds to the muffler inlet pipes.
   Tighten the nuts to specifications. Refer to Section 09-00, Exhaust System General Service.
- 6. Position and install the starter and the starter cable. Refer to Section 03-06A, Starter, Positive Engagement.
- Install the remaining flywheel housing to engine bolts.
- On a vehicle with automatic transmission, install the converter-to-flywheel attaching bolts. Install the converter inspection plate or the rear cover plate on manual transmissions.
- Remove the support from the transmission and lower the vehicle.
- If so equipped, connect the A/C compressor magnetic clutch lead wire. Refer to Section 12-03A, A/C—Heater System F-Series and Bronco.
- 11. Connect the water temperature sending unit wire.
- Connect the accelerator cable bracket to the intake manifold. Connect the transmission and throttle linkage to the throttle body, and speed control linkage, if so equipped.
- 13. Connect the fuel lines. Reconnect evaporative emission hoses at the evaporative canister.
- 14. Install the pulley, belt, spacer and fan. Position the fan shroud over the fan.

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 Position the alternator and install the alternator bolts. Connect the battery ground cable. Adjust the belt tension to specification. Refer to Section 03-05, Engine Accessory Drive.

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- If so equipped, connect two A/C lines to the A/C compressor. Refer to Section 12-03A, A/C—Heater System F-Series and Bronco.
- 17. Install the radiator. Refer to Section 03-03 Engine Cooling. Connect the radiator upper and lower hoses. Connect the transmission oil cooler lines, if so equipped, and engine oil cooler. Install the fan shroud.
- If so equipped, install the A/C condenser to the radiator. Refer to Section 12-03A, A/C—Heater System F-Series and Bronco.
- Connect the heater hose at the water pump. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling. Fill the crankcase with the proper grade and quantity of oil. Connect the power brake booster vacuum hose, if so equipped.
- 20. Operate the engine at fast idle and check all gaskets and hose connections for leaks.
- 21. Install the air outlet tubes to the throttle body and upper intake manifold including the crankcase ventilation hose and carbon canister hose.
- 22. Evacuate and charge the A/C system, if so equipped. Refer to Section 12-03, Air Conditioning, General Service.
- 23. Install hood. Refer to Section 01-02, Body Panels Front End.

### Crankshaft

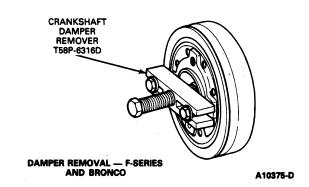
To perform the following operation, it is necessary to remove the engine and install it on a work stand.

Crankshaft and related parts are shown.

### Removal

- Disconnect the wires from the spark plugs using Spark Plug Wire Remover T74P-6666-A or equivalent. Remove the spark plugs to allow easy rotation of crankshaft.
- 2. Remove the oil filter. Slide water pump bypass hose clamp toward the water pump.
- Remove the crankshaft pulley from the vibration damper.

 Remove the bolt and washer from the end of the crankshaft. Install Crankshaft Damper Remover T58P-6316-D or equivalent on the crankshaft vibration damper and remove damper. Remove Woodruff key.



 Remove the cylinder front cover and water pump as an assembly. Check the timing chain deflection. Refer to Section 03-00, Engine, Gasoline—General Service. Remove the timing chain and sprockets as detailed in Under Front Cover and Timing Chain Removal.

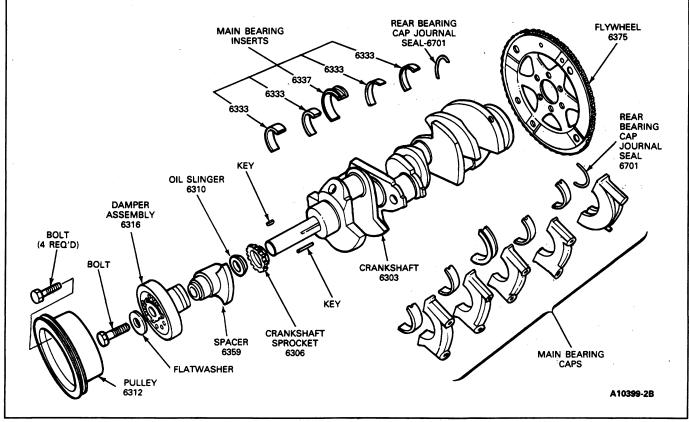
- 6. Invert the engine on a work stand. Remove the flywheel and the engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.
- Ensure all bearing caps, (main and connecting rod), are marked for installation into their original locations.

Turn the crankshaft until the connecting rod from which cap is being removed is down, then remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all connecting rod bearing caps are removed.

- 8. Remove the main bearing caps.
- Carefully lift the crankshaft out of the block so thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to finished surfaces.

Refer to Section 03-00, Engine, Gasoline—General Service for cleaning and inspection procedures. Clean the crankshaft damper.

To refinish journals and dress minor imperfections, refer to Section 03-00, Engine, Gasoline—General Service.

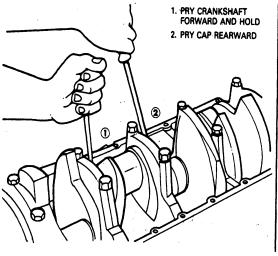


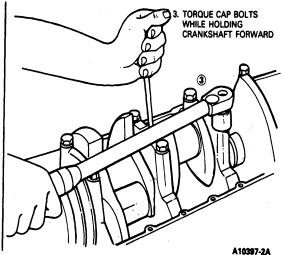
### Installation

- Remove the rear journal oil seal from block and rear main bearing cap.
- 2. Remove the main bearing inserts from the block and bearing caps.
- 3. Remove the connecting rod bearing inserts from the connecting rods and caps.

- NOTE: If the original bearings are to be reused, all bearings should be marked for installation into their original locations.
- 4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearing. Ensure bearing inserts and bearing bores are clean. Foreign material under inserts will distort the bearing and cause failure.
- Place the upper main bearing inserts in the bores with tang in slot.
  - CAUTION: The oil holes in the bearing inserts must be aligned with the oil holes in the cylinder block.
- 6. Install lower main bearing inserts in bearing caps.
- Clean the rear journal oil seal groove and mating surfaces of the block and rear main bearing cap.
- Install a new rear main bearing oil seal in the block and cap. Refer to Section 03-00, Engine, Gasoline—General Service.

- Carefully lower the crankshaft into place. Be careful not to damage bearing surfaces.
- Check the clearance of each main bearing. Refer to Section 03-00, Engine, Gasoline—General Service.
- 11. After bearings have been fitted, apply light coat of specified engine oil to journals and bearings. Install a new seal in the rear main bearing cap and install the rear main bearing cap. Install all bearing caps except thrust bearing cap (No. 3 bearing). Ensure main bearing caps are installed in original locations. Tighten the bearing cap bolts to 129-142 N·m (95-105 ft-lb).
- Install the thrust bearing cap with bolts finger-tight.
- 13. Pry the crankshaft forward against thrust surface of upper half of bearing.
- Hold crankshaft forward and pry thrust bearing cap to rear. This aligns the rear thrust surfaces of both halves of bearing.





- Retain forward pressure on the crankshaft.
   Tighten cap bolts to 129-142 N·m (95-105 ft-lb).
- 16. Force the crankshaft toward the rear of engine.
- 17. Check the crankshaft end play. Refer to Section 03-00, Engine, Gasoline—General Service.
- 18. Install new bearing inserts in the connecting rods and caps. Check clearance of each bearing. Refer to Section 03-00, Engine, Gasoline—General Service under Fitting Bearings with Plastigage. Also, refer to Specifications in this Section.
- After the connecting rod bearings have been fitted, apply light coat of specified engine oil to journals and bearings.

- 20. Turn the crankshaft throw to bottom of its stroke. Push the piston all the way down until rod bearing seats on the crankshaft journal. Cover rod bolt ends with section of rubber hose to prevent crankshaft journal damage during installation.
- 21. Install the connecting rod cap. Ensure connecting rod bolt heads are properly seated in connecting rod. Tighten nuts to 55-61 N-m (41-45 ft-lb).
- 22. After piston and connecting rod assemblies have been installed, check side clearance between connecting rods on each connecting rod crankshaft journal. Refer to Specifications.
- Install timing chain and sprockets, oil slinger, damper spacer, cylinder front cover, and crankshaft damper as detailed in Front Cover and Timing Chain Installation.

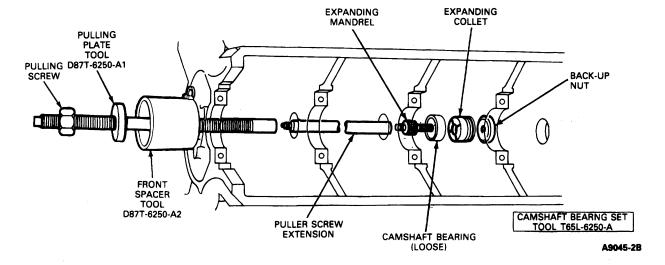
- Install the engine rear cover plate. Position flywheel on crankshaft flange. Install and tighten the bolts to 103-115 N-m (75-85 ft-lb).
- 25. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling inlet port with engine oil and rotating pump shaft to distribute oil within housing. Install oil pump and oil pan by following procedures under Oil Pan Installation.
- 26. Install the oil filter, and connect the fuel lines.
- Install the spark plugs and connect the spark plug wires.
- 28. Install the engine in vehicle as outlined.

### **Camshaft Bearings**

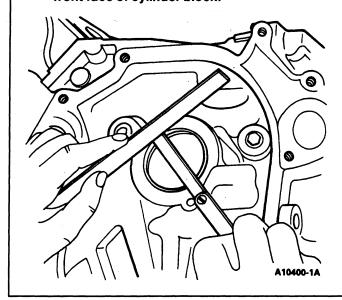
Camshaft bearings are available prefinished to size for standard and undersize journal diameters.

### Removal

- With engine removed and placed in a work stand, remove the camshaft, flywheel, and crankshaft as outlined. Push pistons to top of cylinders.
- Remove the camshaft rear bearing bore plug. Refer to Section 03-00, Engine, Gasoline—General Service.
- Select the proper size expanding collet and backup nut and assemble onto expanding mandrel. With the expanding collet collapsed, install the collet in the camshaft bearing. Tighten backup nut on expanding mandrel until collet fits camshaft bearing.
- 4. Assemble the puller screw and extension, if necessary, as shown and install on expanding mandrel. Wrap a cloth around threads of the puller screw to protect the front bearing or journal. Tighten pulling nut against the thrust bearing and pulling plate to remove camshaft bearing. Hold a wrench on the end of puller screw to prevent it from turning.
- Repeat the procedure for each bearing. To remove the front bearing, install puller screw from rear of cylinder block.
- Position new bearings at bearing bores, and press in place with the tool. Ensure to center the pulling plate and puller screw to avoid bearing damage.



CAUTION: Failure to use correct expanding collet can cause severe bearing damage. Align oil holes in bearings with oil holes in cylinder block before pressing them into block. Ensure front bearing is installed 0.054-0.081mm (0.002-0.003 inches) below front face of cylinder block.



### **DISASSEMBLY AND ASSEMBLY**

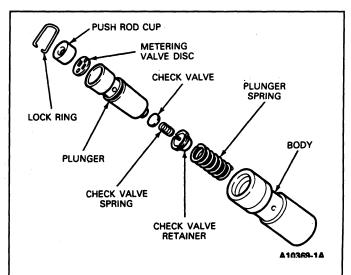
When installing nuts or bolts that must be tightened, oil the threads with light engine oil. Refer to Specifications for proper torque values. **Do not oil threads requiring oil-resistant or water-resistant sealer.** 

### **Valve Tappet**

Each tappet is a matched assembly. If parts of one are mixed with those of another, improper valve operation may result. Disassemble and assemble each tappet separately. Valve tappets should be tested after assembly. Refer to Section 03-00, Engine, Gasoline—General Service. Keep the tappet assemblies in proper sequence so they can be installed in their original bores.

### Disassembly

- Grasp the lock ring with needlenose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.
- Remove the push rod cup, metering valve (disc), and plunger assembly.
- Carefully remove the plunger spring, check valve retainer spring, check valve retainer and check valve disc from the plunger.
  - Refer to Section 03-00, Engine,
    Gasoline—General Service for cleaning and
    inspection procedures.



### **Assembly**

- Place the plunger upside down on a clean work bench.
- Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
- Position the check valve retainer over the check valve and spring. Then, push the retainer down into place on the plunger.
- 4. Place the plunger spring and the plunger (open end up) into tappet body.
- 5. Position the metering valve (disc) in the plunger, and place push rod seat in the plunger.
- 6. Depress the plunger and position the closed end of lock ring in the groove of the tappet body. With the plunger still depressed, position the open ends of lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.
- Use Leak Down Tester TOOL-6500-E or equivalent, to fill the tappet with test fluid. Refer to Section 03-00, Engine, Gasoline—General Service.

### Cylinder Head

### Disassembly

- With cylinder head removed from engine, remove rocker arm fulcrum bolts, oil deflectors, fulcrum seats, and rocker arms. Remove exhaust manifolds and spark plugs.
- Clean carbon from combustion chambers before removing valves.
- Compress valve springs using Valve Spring Compressor T70P-6049-A or equivalent. Remove spring retainer locks and release springs. Remove retainers, springs, stem seals, and valves. Discard stem seals.

### **DISASSEMBLY AND ASSEMBLY (Continued)**

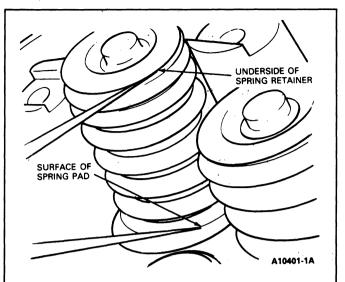
Clean and inspect cylinder head(s) and related components. Refer to Section 03-00, Engine, Gasoline—General Service

Refer to Section 03-00 for cylinder head and valve repair procedures.

### **Assembly**

Lubricate all valves, valve stems and valve guides with specified engine oil. Apply Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the valve tips before installation.

- Install each valve in the port from which it was removed or to which it was fitted. Install new valve stem seal on each valve.
  - NOTE: Ensure the proper seal application for intake and exhaust are in place.
- Set valve spring and retainer over valve stem. Compress spring and install retainer locks.
- 3. With dividers, measure assembled height of valve spring from surface of spring pad on cylinder head to underside of spring retainer. Check dividers with accurate scale. If assembled height exceeds specification, install shim(s) below spring to reduce height to recommended dimension. Refer to Specifications. Reducing assembled height below specifications can cause spring breakage and rapid wear of cam lobe.



- 4. Coat the fulcrum seats and sockets with Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent. Ensure the rocker arm fulcrum bolts are in a serviceable condition before installing them..Install rocker arms, fulcrum seats, oil deflectors and fulcrum bolts as outlined under Valve Rocker Arm Installation.
- Install exhaust manifolds and spark plugs as outlined.

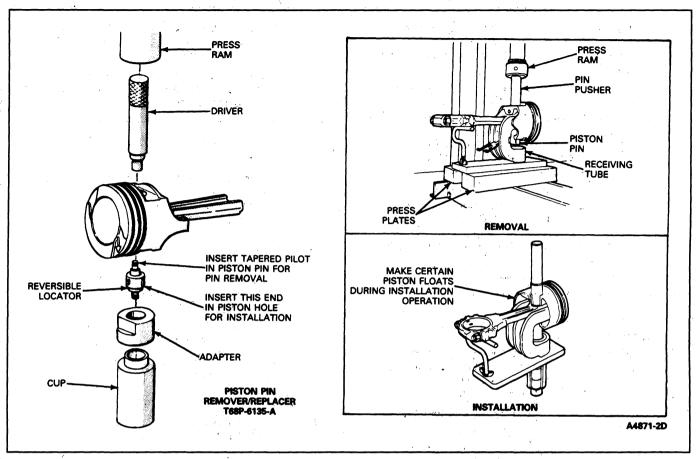
## Piston and Connecting Rod

### Disassembly

- 1. Remove the bearing inserts from the connecting rod and cap.
- Mark the pistons to ensure assembly with same rod and installation in the same cylinders from which they were removed.
- 3. Using an arbor press and Piston Pin Remover / Replacer T68P-6135-A or equivalent shown, press the piston pin from the piston and connecting rod. Remove the piston rings.

Refer to Section 03-00, Engine, Gasoline—General Service for cleaning and inspection procedures. Repair if required.

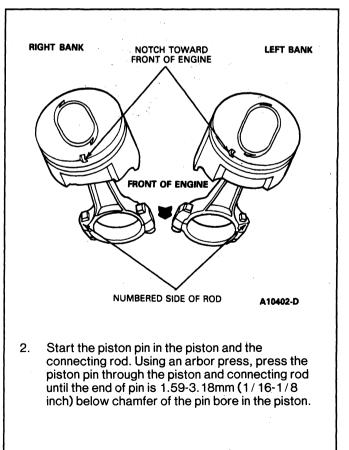
### **DISASSEMBLY AND ASSEMBLY (Continued)**



### **Assembly**

Check the fit of a new piston in the cylinder bore before assembling piston and piston pin to connecting rod. Piston pin bore of connecting rod and diameter of piston pin must be within specifications.

 Apply a light coat of specified engine oil to all parts. Assemble the piston to the connecting rod with the cylinder number side of the connecting rod and indentation notch in piston positioned as shown.



### **DISASSEMBLY AND ASSEMBLY (Continued)**

- Check the end gap of all piston rings. End gap must be within specifications. Follow the instructions contained on piston ring package and install the piston rings.
- 4. Check the ring-side clearance of compression rings with a feeler gauge inserted between the ring and the lower land. Feeler gauge should slide freely around the ring circumference without binding. Any wear will form a step at the inner portion of the lower land. If the lower lands have high steps, replace the piston.
- Ensure the bearing inserts and bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause failure. Install bearing inserts in connecting rod and cap with tangs fitting in slots provided.

### Cylinder Assembly

### Disassembly

- Mount the old engine on a work stand and remove all the parts not furnished with the new cylinder assembly, following the procedures given in Removal and Installation of this section.
- Remove the four cylinder head locating dowels and the block drain plugs.
- Remove the old cylinder assembly from the work stand.

### **Assembly**

- Clean the gasket and seal surfaces of all serviceable parts and assemblies.
- Position the new cylinder assembly on a work stand and install the cylinder head locating dowels and block drain plugs.

- Transfer all serviceable parts removed from the old cylinder assembly, following the procedures given in Removal and Installation of this section.
- Check all assembly clearances following specifications listed at the end of this section and correct as necessary.

### **Cylinder Block**

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs, following the procedures given in Section 03-00, Engine, Gasoline—General Service.

### Disassembly

- Mount the old engine in a work stand and completely disassemble it, following the procedures given in Removal and Installation of this section.
- Ensure that cylinder bores are ridge-reamed before removing piston assemblies, if required.
- Remove the cylinder head locating dowels and the block drain plugs.

### Assembly

- Clean the gasket and seal surfaces of all serviceable parts and assemblies.
- Position the new cylinder block in a work stand and install the cylinder head locating dowels and the block drain plugs.
- Transfer all serviceable parts removed from the old cylinder block, following applicable procedures under Removal and Installation in this section
- Check all assembly clearances following specifications at the end of this section and correct as necessary.

### **SPECIFICATIONS**

### GENERAL SPECIFICATIONS

| , | Engine             | Bore and Stroke | Firing Order | Oli Pressure<br>Hot @ 2000 RPM<br>kPa (PSI) | Engine Type<br>and Number of<br>Cylinder |
|---|--------------------|-----------------|--------------|---|--|
|   | 7.5L (460 CID) V-8 | 4.36 x 3.85     | 15426378     | 276-606 (40-88)                             | O.H.V. V-8                               |

### CYLINDER HEAD

|   | Engine               | Combustion<br>Chamber<br>Volume | Valve Guide<br>Bore<br>Diameter |           | Valve Seat<br>Width ① |         | Valve Seat<br>Runout TIR<br>Maximum | Valve Arrangement Front to Rear          | Gasket<br>Surface<br>Flatness |
|---|----------------------|---------------------------------|---------------------------------|-----------|-----------------------|---------|-------------------------------------|--|-------------------------------|
| . | in the second second | C.C. ③                          | Intake                          | Exhaust   | Intake                | Exhaust | maxiiridiii                         | Tront to hear                            | 2                             |
|   | 7.5L (460 CID) V-8   | 95.7-98.7                       | .34333443                       | .34333443 | .060080               | .060080 |                                     | RT I-E-I-E-I-E-I-E<br>LT E-I-E-I-E-I-E-I |                               |

① Valve seat angle — 45°.

② Gasket surface finish — RMS 60-150.

3 Compression pressure (PSI) of the lowest cylinder must be at least 75% of the highest to be within specification.

### VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

| VALVE ROCKER ARM SHA | FT, PUSH ROD                  | S AND TAPPETS   | es.                  |                     | · · · · · · · · · · · · · · · · · · · | · Jew     |         |
|----------------------|-------------------------------|-----------------|----------------------|---------------------|---------------------------------------|-----------|---------|
|                      |                               | Push Rod Runout | V                    | aive Tappet o       | Collapsed Tappet Gap<br>(Clearance)   |           |         |
| Engine               | Rocker Arm<br>Lift Ratio to 1 | TIR Maximum     | Standard<br>Diameter | Clearance to Bore ① | Hydraulic Lifter<br>Leakdown Rate     | Allowable | Desired |
| 7.5L (460 CID) V-8   | 1.73                          | .015            | .87408745            | .00070027           | 10 to 50 seconds<br>for 1/16 travel   | .075175   | .100150 |

Time required for plunger to leakdown .0625 in. under load of 50 lbs. using leakdown fluid in tappet.

| Engine             | Valve Spring Compression Pressure Lbs. @ Specified Height |                                | Free   | Spring<br>Length<br>ximate) | Valve<br>Asser<br>Hel | Valve Spring<br>Out of<br>Square |             |
|--------------------|---|--------------------------------|--------|-----------------------------|-----------------------|----------------------------------|-------------|
|                    | Intake ①  | Exhaust                        | Intake | Exhaust                     | Intake                | Exhaust                          | Maximum     |
| 7.5L (460 CID) V-8 | 76-84 @ 1.81<br>218-240 @ 1.33                            | 76-84 @ 1.81<br>218-240 @ 1.33 | 2.06   | 2.06                        | 1-51/64 — 1-53/64     | 1-51/64 — 1-53/64                | 5/64 (.078) |

① Service limit — 10% loss of pressure.

### VALVES

|   | E-ala-             | Valve Stem to Gu | ide Clearance ① | Valve Head  | Valve Face Runout |             |
|---|--------------------|------------------|-----------------|-------------|-------------------|-------------|
| ٠ | Engine             | Intake           | Exhaust         | Intake      | Exhaust           | TIR Maximum |
|   | 7,5L (460 CID) V-8 | .00100027        | .00100027       | 1.965-1.989 | 1.646-1.661.      | .002        |

1) Service clearance — .0055. 2° Valve face angle — 44°.

CA4943-2G

### **VALVES (Continued)**

| E1                 | Stan      | dard      | Valve Stem Diame | ter .015 Oversize | .030 Oversite |           |
|--------------------|-----------|-----------|------------------|-------------------|---------------|-----------|
| Engine             | Intake    | Exhaust   | Intake           | Exhaust           | Intake        | Exhaust   |
| 7.5L (460 CID) V-8 | .34153423 | .34153423 | .35653573        | .35653573         | .37153723     | .37153723 |

### CAMSHAFT

| Englis             | Lobe   | Lift ①  | Camshaft | End Play      | Camshaft Journal to |
|--------------------|--------|---------|----------|---------------|---------------------|
| Engine             | Intake | Exhaust | End Play | Service Limit | Bearing Clearance ② |
| 7.5L (460 CID) V-8 | .252   | .278    | .001006  | .009          |                     |

Maximum allowable lift loss — .005.
 Service limit — .006.

### CAMSHAFT DRIVE

| Engine             | Ca    |                   | mshaft Journal Diameter —<br>Standard ① |       |       | Çamehaft Bearing Inside Diameter |       |       |       | Camshaft Front<br>Bearing | Denection |                       |
|--------------------|-------|-------------------|---|-------|-------|----------------------------------|-------|-------|-------|---------------------------|-----------|-----------------------|
| Linguis            | No. 1 | No. 2             | No. 3                                   | No. 4 | No. 5 | No. 1                            | No. 2 | No. 3 | No. 4 | No. 5                     |           | <b>Inches Maximum</b> |
| 7.5L (460 CID) V-8 |       | 2.1238-<br>2.1248 |   |       |       |                                  |       |       |       |                           | .040060   | .500                  |

### CYLINDER BLOCK

| Engine             | Cylinder Bore<br>Diameter ① | Main Bearing<br>Bore<br>Diameter | Distributor Shaft<br>Bearing Bore<br>Diameter | Head Gasket<br>Surface Flatness   | Head Gasket<br>Surface Finish | Tappet Bore<br>Diameter |
|--------------------|-----------------------------|----------------------------------|---|-----------------------------------|-------------------------------|-------------------------|
| 7.5L (460 CID) V-8 | 4.3600-4.3636               | 3.1922-3.1934                    | .51605175                                     | .003 in any 6 in.<br>.006 overall | RMS 90-150                    | .87528767               |

① Maximum out-of-round — .0015, Service limit — .005, Maximum taper service limit — .010, Cylinder bore surface finish RMS 18-38, Bore taper service limit — .010

### CRANKSHAFT AND FLYWHEEL

| Engine             | Main Bearing<br>Journal<br>Diameter ① | Main Bearing<br>Journal Runout<br>TIR Maximum ② | Thrust Face |       | Thrust Bearing<br>Journal Length |    |                       |
|--------------------|---------------------------------------|---|-------------|-------|----------------------------------|----|-----------------------|
| 7.5L (460 CID) V-8 | 2.9994-3.0002                         | .002  | .001        | .0005 | 1.124-1.126                      | 12 | 25 Front — 23<br>Rear |

① Maximum out-of-round — .0006.

### CRANKSHAFT AND FLYWHEEL (Continued)

| Engine             | Engine Connecting Rod Journal Diameter ① |       | Crankshaft Free End Play ② |  |
|--------------------|--|-------|----------------------------|--|
| 7.5L (460 CID) V-8 | 2.4992-2.5000                            | .0006 | .004008                    |  |

Maximum out-of-round — .0006.
 Service limit — .012.

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Camshaft journal runout — .005 TIR maximum.
 Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

Service limit — .005.

### **CRANKSHAFT BEARINGS**

| Engine             | Connecting Re | od Bearing to Cranks<br>Selective Fit | haft Clearance                   | Main Bearing to Grankshaft Clearance<br>Selective Fit |           |                                  |  |
|--------------------|---------------|---------------------------------------|----------------------------------|---|-----------|----------------------------------|--|
| Engine             | Desired       | Allowable                             | Bearing Wall<br>Thickness Std. ① | Desired   | Allowable | Bearing Wall<br>Thickness Std. ① |  |
| 7.5L (460 CID) V-8 | .00080015     | .00080025                             | .07570762                        | .00080015   | .00080026 | .09550960                        |  |

① For .002 undersize add .001 to standard wall thickness.

### **CONNECTING ROD**

| Engine             | Piston Pin Bore<br>or Bushing I.D. | Rod Bearing<br>Bore I.D. ① | Rod Length<br>Center to Center | Connecting R<br>Maximum To |        | Rod to Crankshaft<br>Assembled<br>Side Clearance 3 |  |
|--------------------|------------------------------------|----------------------------|--------------------------------|----------------------------|--------|--|--|
| t.                 | or busning i.D.                    | Bore I.D. (I               | Center to Center               | Twist ②                    | Bend ② |  |  |
| 7.5L (460 CID) V-8 | 1.0386-1.0393                      | 2.6522-2.6530              | 6.6035-6.6065                  | .024                       | .012   | .010020  |  |

① Connecting rod bearing bore maximum out-of-round — .0004.

### PISTON

| Engine             |               | Diameter ①    |               | Platon to<br>Bore Clearance | Piston<br>Pin Bore | Ring Groove Width<br>Compression |           |         |  |
|--------------------|---------------|---------------|---------------|-----------------------------|--------------------|----------------------------------|-----------|---------|--|
|                    | Coded Red     | Coded Blue    | .003 Oversize | Selective Fit               | Diameter           | Тор                              | Bottom    | Oli     |  |
| 7.5L (460 CID) V-8 | 4.3577-4.3583 | 4.3589-4.3595 | 4.3601-4.3607 | .00220030                   | 1.0401-1.0406      | .08050815                        | .08050815 | .188189 |  |

① Measured at the piston pin bore centerline at 90° to the pin.

### SERVICE PISTON SELECTION

| Piston Bore Diameter                   | I.D. Code of Service<br>Platon Required |
|--|---|
| 110.744-110.774 mm (4.3600-4.3612 in.) | Red                                     |
| 110.774-110.805 mm (4.3612-4.3624 in.) | Blue                                    |
| 110.805-110.835 mm (4.3624-4.3636 in.) | Yellow                                  |

When replacing pistons, measure cylinder bore as described in General Gasoline Engine Service, Section 21-01. Install service piston matched to piston bore diameter above.

### PISTON PIN

| Englas             | Longib      | Dian          | neter         | To Piston Pin    | To Connecting Rod |  |
|--------------------|-------------|---------------|---------------|------------------|-------------------|--|
| Engine             | Length      | Standard      | .001 Oversize | Bore Clearance ① | Bushing Clearance |  |
| 7.5L (460 CID) V-8 | 3.290-3.320 | 1.0398-1.0403 | 1.0410-1.0413 | .00020005        | Interference Fit  |  |

<sup>1</sup> Selective Fit.

### **PISTON RINGS**

|                    | Ring Width | Compression | S         | ide Clearance ( | )    | Ring Gap               |         |         |  |
|--------------------|------------|-------------|-----------|-----------------|------|------------------------|---------|---------|--|
| Engine             | Ton        | Bottom      | Compr     | ession          | Oli  | Compression (in Gauge) |         |         |  |
|                    | Тор        | Bottom      | Тор       | Bottom          | Oil  | Тор                    | Bottom  | Oil     |  |
| 7.5L (460 CID) V-8 | .077078    | .07700780   | .00250045 | .00250045       | Snug | .010020                | .010020 | .010035 |  |

<sup>1)</sup> Service limit — .002 maximum increase in clearance.

### OIL PUMP AND OIL CAPACITY

| Engine |                    | Relief Valve                                  | Driveshaft to        | Relief Valve            |                                 | Outer Race              | Engir                   | e Oll Capaci | y ①    | Inner to                     |
|--------|--------------------|---|----------------------|-------------------------|---------------------------------|-------------------------|-------------------------|--------------|--------|------------------------------|
|        | Engine             | Spring Pressure<br>Lbs. @ Specified<br>Length | Housing<br>Clearance | to Housing<br>Clearance | Rotor Assembly<br>End Clearance | to Housing<br>Clearance | U.S. Qts. Imperial Qts. |              | Liters | Outer Rotor<br>Tip Clearance |
|        | 7.5L (460 CID) V-8 | 20.6-22.6 @ 2.49                              | .00150030            | .00150030               | .004 Maximum                    | .001013                 | 5                       | 4.2          | 4.7    | .012                         |

① Add 1 U.S. quart (or equivalent in Imperial quarts or liters) when replacing filter.

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② Pin bushing and crankshaft bore must be parallel and in same vertical plane within specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

<sup>3</sup> Service limit — .023.

TORQUE LIMITS — 7.5L (480 CID) EFI V-8 ENGINE
NOTE: All values are in N·m (ft-lbs) unless otherwise noted. Oil threads with engine oil unless the threads require oil or water-resistant sealer. The standard torque ilmits listed below are applicable for all functions not listed in the special torque chart.

| 1/4-20     | 5/16-18       | 5/16-24       | 3/8-16        | 3/8-24        | 7/16-14       | 7/16-20       | 1/2-13        | 9/16-18          |
|------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|------------------|
| 8-12 (6-9) | 17-24 (12-18) | 19-27 (14-20) | 30-43 (22-32) | 37-51 (27-38) | 61-77 (45-57) | 55-81 (40-60) | 75-81 (55-60) | 116-162 (85-120) |

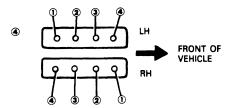
PIPE THREADS

| 1/8-27     | 1/4-18        | 3/8-18        | 1/2-14        |
|------------|---------------|---------------|---------------|
| 7-11 (5-8) | 17-24 (12-18) | 30-44 (22-23) | 34-47 (25-35) |

| Item   | Toro                            |                                |
|--|---------------------------------|--------------------------------|
|  | N-m                             | (ft-lbs)                       |
| Camshaft Sprocket — Gear to Camshaft         | 55-68                           | (40-50)                        |
| Camshaft Thrust Plate to Cylinder Block      | 8-12                            | (70-105 in-lb)                 |
| Connecting Rod Nut                           | 55-61                           | (41-45)                        |
| Cylinder Front Cover — 5/16"                 | 17-24                           | (12-18)                        |
| Cylinder Head Bolts                          | (                               | )                              |
| Damper to Crankshaft                         | 95-122                          | (70-90)                        |
| Distributor Clamp Down                       | 24-33                           | (17-25)                        |
| EGR Valve to Upper Intake Manifold           | 8-11                            | (70-100 in-lb)                 |
| Flywheel to Crankshaft                       | 103-115                         | (75-85)                        |
| Main Bearing Cap Bolts                       | 129-142                         | (95-105)                       |
| Manifold to Cylinder Head — Intake           | (3                              |                                |
| Intake Manifold Vacuum Fittings ②            | 8-13                            | ( 6-10)                        |
| Manifold to Cylinder Head — Exhaust          | 30-60                           | (22-45)                        |
| Oil Filter Insert to Cylinder Block/Adaptor  | 61-203                          | (45-150)                       |
| Oil Cooler to Cylinder Block                 | 54-88                           | (40-65)                        |
| Oil Filter to Oil Cooler                     | 1/2 turn after gaseling surface | asket contacts  — oiled gasket |
| Oil Inlet Tube to Pump                       | 17-24                           | (12-18)                        |
| Oil Inlet Tube to Main Bearing Cap           | 30-43                           | (22-32)                        |
| Oil Pan Drain Plug                           | 21-33                           | (15-25)                        |
| Oil Pan to Cylinder Block                    | 1/4" 10-12<br>5/16" 11-15       | ( 7-9 )<br>( 8-11)             |
| Oil Pump to Cylinder Block                   | 30-43                           | (22-32)                        |
| Crankshaft Pully to Damper Bolt              | 55-70                           | (40-50)                        |
| Rocker Arm Stud/Bolt to Cylinder Head        | 25-33                           | (18-25)                        |
| Spark Plug to Cylinder Head                  | 7-13                            | ( 5-10)                        |
| Valve Rocker Arm Cover                       | (a)                             | )                              |
| Water Outlet Housing                         | 16-24                           | (12-18)                        |
| Water Pump to Cylinder Block or Front Cover  | 16-24                           | (12-18)                        |
| Alternator Bracket to Water Pump Bolt        | 46-54                           | (34-40)                        |
| Alternator Pivot Bolt                        | 54-68                           | (40-50)                        |
| Alternator Adjusting Arm to Water Pump Bolt  | 46-54                           | (34-40)                        |
| Alternator Adjusting Arm to Alternator Bolt  | 46-54                           | (34-40)                        |
| Thermactor Pump Bracket to Cylinder Block    | 46-54                           | (34-40)                        |
| Thermactor Pump Pivot Bolt                   | 46-54                           | (34-40)                        |
| Thermactor Pump to Pump Bracket              | 46-54                           | (34-40)                        |
| Thermactor Pump Pulley to Pump Hub           | 11-15                           | (97-133 in-lb)                 |
| Thermactor Pump Bracket to Head (Upper Bolt) | 40-55                           | (30-40)                        |
| Thermactor Pump Bracket to Head (Lower Bolt) | 55-70                           | (40-50)                        |
| A/C Compressor or Idler to Bracket           | 40-55                           | (30-40)                        |
| Automatic Belt Tensioner to Bracket          | 70-90                           | (50-65)                        |
| Power Steering Bracket to Head               | 55-70                           | (40-50)                        |
| Power Steering Bracket to Water Pump         | 40-55                           | (30-40)                        |
| Power Steering Pump to Bracket               | 40-55                           | (30-40)                        |

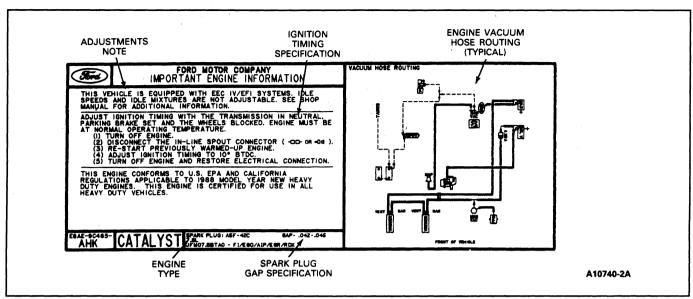
Torque in steps: first to 95-108 N-m (70-80 ft-lbs), then to 136-149 N-m (100-110 ft-lbs), final to 177-189 N-m (130-140 ft-lbs). Index to correct position in tightening direction.

Torque in steps: first to 11-16 N-m (8-12 ft-lbs), then to 16-30 N-m (12-22 ft-lbs), final to 30-47 (22-35 ft-lbs).



Torque to 12-15 N·m (9-11 ft-lbs) in sequence as shown.

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### SPECIAL SERVICE TOOLS

| Tool Number   | Description                          |
|---------------|--------------------------------------|
| D79P-100-A    | Impact Slide Hammer                  |
| T50T-100-A    | Impact Slide Hammer                  |
| T58L-101-B    | Puller Attachment                    |
| T59L-100-B    | Impact Slide Hammer                  |
| T72J-1177     | Bearing Housing Seal Replacer        |
| D78P-4201-B   | Dial Indicator Mag. Base             |
| TOOL-4201-C   | Dial Indicator With Bracketry        |
| T70P-6000     | Engine Lifting Brackets              |
| T75T-6000-A   | Engine Lifting Plate                 |
| T64L-6011-EA  | Cylinder Ridge Reamer                |
| T73L-6011-A   | Cylinder Hone Set                    |
| T68P-6019-A   | Front Cover Aligner                  |
| T70P-6049-A   | Valve Spring Compressor              |
| T68P-6135-A   | Piston Pin Remover/Replacer          |
| T70P-6B070-A  | Front Cover Seal Replacer            |
| T70P-6B070-B  | Front Cover Seal Remover             |
| D81L-6002-C   | Piston Ring Compressor               |
| T65L-6250-A   | Cam Bearing Set                      |
| T52L-6306-AEE | Crankshaft Damper & Sprocket Replace |
| T58P-6316-D   | Crankshaft Damper Remover            |
| TOOL-6331-E   | Main Bearing Insert Tool             |
| T74P-6375-A   | Flywheel Holding Tool                |
| TOOL-6500-E   | Hydraulic Tappet Leakdown Tester     |
| T71P-6513-B   | Tappet Bleed Down Wrench             |
| TOOL-6513-DD  | Valve/Clutch Spring Tester           |
| T73L-6600-A   | Pressure Gauge                       |
| D79P-6666-A   | Spark Plug Boot Puller               |
| T74P-6666-A   | Spark Plug Wire Remover              |
| T74P-7137-A   | Pilot Bearing Replacer               |
| T73P-6571-A   | Valve Seal installer                 |
| D80L-522-A    | Gear and Pulley Puller               |
| D87T-6250-A   | Cam Bearing Installer                |

## SECTION 03-01D Diesel Engine - 7.3L V-8

| SUBJECT                                   | PAGE        | SUBJECT                                       | PAGE       |
|---|-------------|---|------------|
| ADJUSTMENTS                               | 03-01D-27   | REMOVAL AND INSTALLATION (Cont'd.)            |            |
| CLEANING AND INSPECTION                   |             | Camshaft Drive Gear, Fuel Pump Cam, Spacer    |            |
| Camshaft                                  | 03-01D-90   | and Thrust Plate                              | 03-01D-47  |
| Connecting Rods                           | 03-01D-92   | Core Plugs                                    | 03-01D-78  |
| Crankcase Depression Regulator            |             | Crankcase Depression Regulator                |            |
| (CDR)                                     | 03-01D-87   | (CDR)   | 03-01D-49  |
| Crankshaft                                | 03-01D-91   | Crankshaft                                    | 03-01D-75  |
| Crankshaft Vibration Damper               | 03-01D-91   | Crankshaft Drive Gear                         | 03-01D-44  |
| Cylinder Block                            | 03-01D-93   | Crankshaft Vibration Damper                   | 03-01D-37  |
| Cylinder Heads                            |             | Cylinder Block                                | 03-01D-85  |
| Drive Gears                               |             | Cylinder Head                                 |            |
| Exhaust Manifolds                         | 03-01D-90   | Cylinder Heads                                | 03-01D-66  |
| Flywheel                                  | 03-01D-91   | Engine Assembly                               |            |
| Flywheel                                  |             | Engine Front Cover and Crankshaft Oil         |            |
| Hydraulic Valve Tappets                   |             | Seal  | 03-01D-39  |
| Intake Manifold                           |             | Engine Front Insulators                       |            |
| Main and Connecting Rod Bearing           |             | Engine Oil Cooler                             |            |
| Oil Cooler                                |             | Engine Oil Filter                             |            |
| Oil Pan                                   |             | Engine Rear Insulator                         |            |
| Oil Pump                                  |             | Exhaust Manifolds                             |            |
| Pistons, Pins and Rings                   |             | Fitting Main or Connecting Rod Bearings With  |            |
| Push Rods                                 |             | Plastigage                                    |            |
| Thermostat                                |             | Flywheel Ring Gear                            |            |
| Valve Rocker Arm Assembly                 |             | Flywheel, Engine Rear Cover and Oil           | 00 0 10 44 |
| DESCRIPTION AND OPERATION                 | 05-0 1D-01  | Seal  | 03-010-42  |
| Coolant Flow                              | 03-010-7    | Front Crankshaft Oil Seal                     |            |
| Dual Mass Flywheel (Manual Transmission   | 05-010-7    | Fuel Supply Pump                              |            |
| Only)                                     | 02-010-19   | Injection Nozzle Fuel Lines                   |            |
| Engine Components                         |             | Injection Nozzles                             |            |
| Engine Description                        |             | Injection Pump                                |            |
| Fuel Flow                                 |             | Injection Pump Drive Gear and Gear            | 03-0 10-34 |
| Glow Plug Fast Start System               |             | Cover   | 02.010.46  |
| •   |             |   | 03-0 10-46 |
| Injection Nozzle Assemblies               |             | Intake Manifold, Valley Pan and               | 02.010.61  |
| Lubrication System                        |             | TappetsOil Pan, Oil Pump and Oil Pick-Up Tube | 02 010 70  |
| Vehicle and Engine Identification         |             | Overhaul                                      |            |
| DIAGNOSIS AND TESTING                     | 03-0 10- 16 |   |            |
|   |             | Piston and Connection Rod Assembly            |            |
| Diagnostic Procedures — Engine Components | 02.040.04   | Pistons and Connecting Rods                   |            |
| MAINTENANCE                               | 03-0 10-2 1 | Pistons, Pins and Rings                       | 03-0 10-63 |
| Accelerator Linkage                       | 02.040.05   | Repairing Engine Casting Holes and Porosities | 02.010.96  |
| Engine Fuel Filter                        |             |   |            |
| Engine Idle Speed                         |             | Secondary Flywheel                            |            |
|   |             | Thermostat                                    |            |
| Engine Oil Level                          | 95          | Valve Cover, Rocker Arm, and Push Rod         |            |
| Fuel Filter/Fuel Heater/Water             | 02 040 05   | Valves  |            |
| Separator REMOVAL AND INSTALLATION        | บง-บ 1บ-95  | Valves  |            |
| Camshaft                                  | 00.040.70   | Water Pump                                    | to a       |
|   |             | SPECIFICATIONS                                |            |
| Camshaft Bearings                         | 03-010-77   | VEHICLE APPLICATION                           | 03-010-1   |

### **VEHICLE APPLICATION**

F-250 Through F-350, F-Super Duty Chassis Cab, Stripped Chassis and E-250 Through E-350 Vehicles

### **DESCRIPTION AND OPERATION**

### **Engine Description**

The 7.3L diesel engine is a four-cycle, naturally aspirated V-8 with overhead valves. It displaces 7.3 liters (444 cu. in.). The right bank of cylinders are numbered 1, 3, 5, 7, with number 1 being at the front. The firing order is 1-2-7-3-4-5-6-8.

The crankcase has been especially designed to withstand the loads of diesel operation. It utilizes four bolt main bearing caps to provide a strong support for the rotating parts. The crankcase also incorporates internal piston oil cooling jets which direct oil to the underside of the piston.

The crankshaft is a five main bearing unit with fore and aft thrust controlled at the center (NO. 3) bearing. Heavy-duty forged steel connecting rods attach to the crankshaft, two to each bearing throw. The piston pin is a free floating-type, permitting the pin to move or float freely in piston and rod. The piston pin is retained by snap-rings.

The camshaft is supported by five insert-type bearings pressed into the block. It is driven by a gear keyed to the crankshaft. Camshaft end thrust is controlled by a thrust flange located between the front camshaft journal and the thrust flange spacer.

The aluminum-alloy pistons are fitted with two compression rings and one oil ring.

The hydraulic valve tappets minimize engine noise and maintain zero valve lash (tappet clearance). This eliminates the need for periodic adjustment. The hydraulic valve tappets incorporate camshaft roller followers for improved camshaft wear characteristics.

The cylinder head assemblies feature pre-combustion chambers which provide superior combustion characteristics. The cylinder head assemblies are equipped with positive valve-rotating mechanisms located at the bottom of the intake and exhaust valve springs.

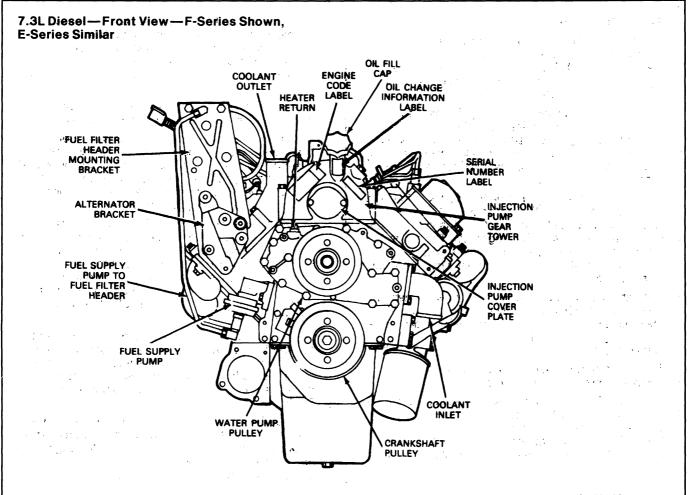
A solid-state glow plug system and block heater provide excellent cold weather start capability.

The engine is equipped with a combination fuel filter/fuel heater/water separator. The E-Series locates the fuel filter assembly on a bracket on the RH side of the engine. The F-Series locates the fuel filter assembly on the LH side of the engine by utilizing a filter base with an integral filter bracket.

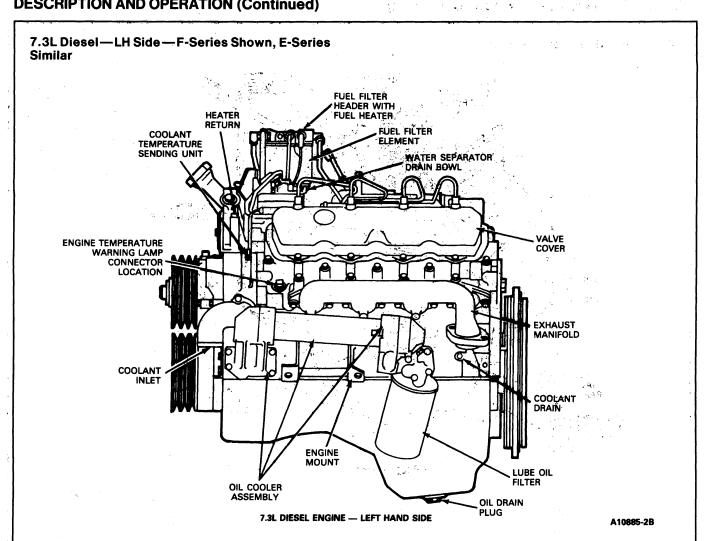
The engine is equipped with a fully closed crankcase ventilation system. Crankcase vapors are directed to the intake manifold from a port in the Crankcase Depression Regulator (CDR) valve. It regulates crankcase pressure by providing a connection between the valley pan and the intake manifold. The crankcase depression regulator (CDR) valve is mounted on the intake manifold.

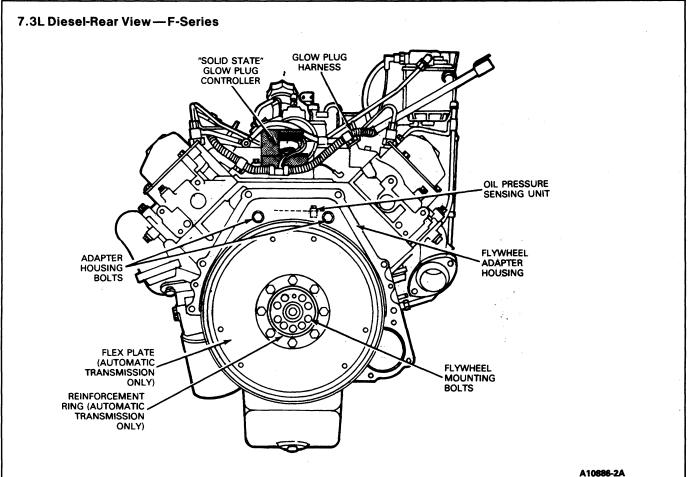
The rotary-type injection pump is located between the cylinder heads in a recess in the front of the engine. The engine governor is integral with the fuel injection pump. Operating principles and service instructions for the fuel system components are also provided in this Section.

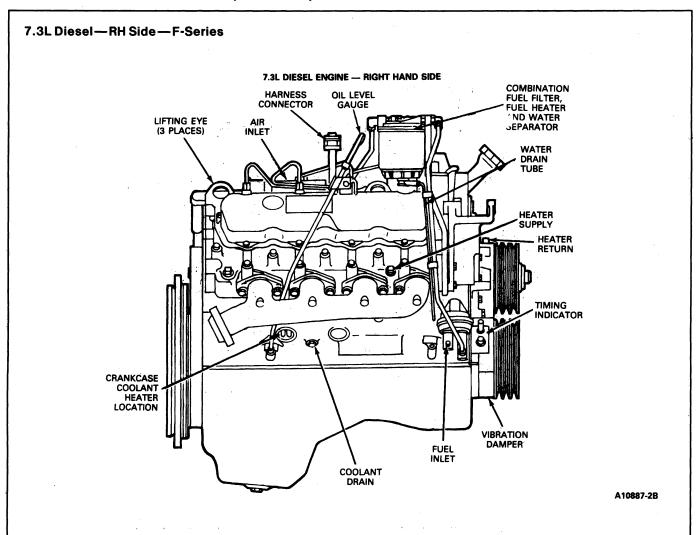
The Fuel Injection Pump used on the 7.3 Liter Diesel Engine is located between the cylinder heads and the intake manifold in the vee at the front of the engine. It is an opposed plunger, inlet metered, positive displacement, distributor type pump.

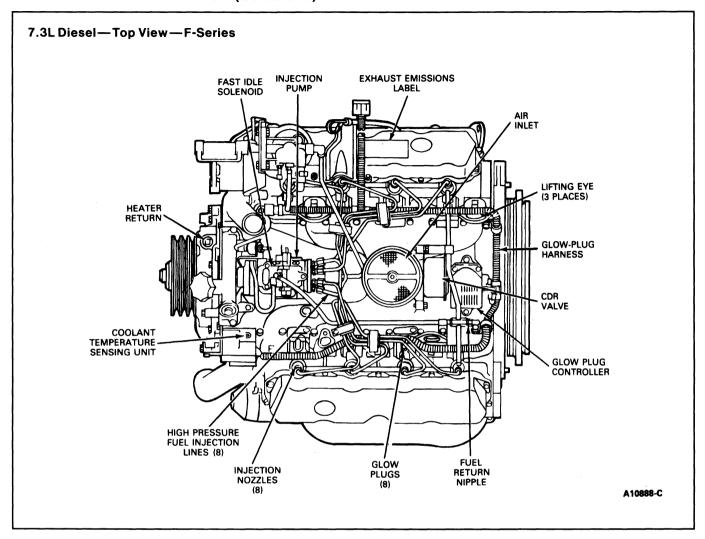


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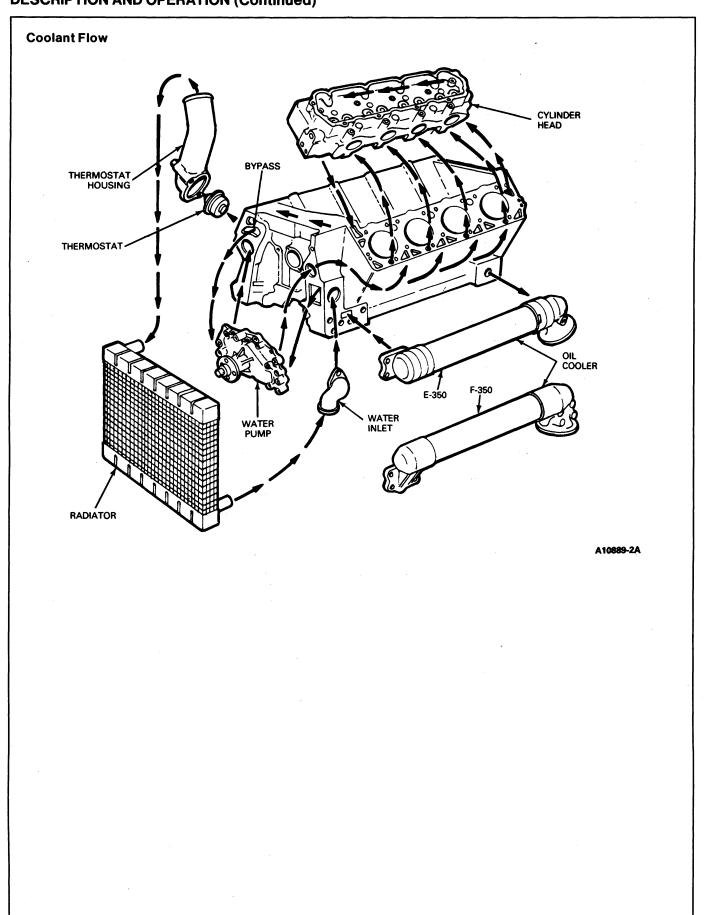
### **Coolant Flow**

Coolant flows from the radiator to the water pump, to the engine RH and LH banks.

Circulation of the coolant is from the front to the rear of the crankcase. Coolant flows from crankcase to the cylinder head through positive cooling passages, and through one passage at the front and rear bulkhead of the cylinder head. Coolant flows between the pre-combustion chambers and valve seats and towards the front. Coolant exits the cylinder head into a common cavity which runs across the front of the crankcase. The common cavity routes coolant to the thermostat housing.

When the thermostat is closed, coolant bathes the thermostat and runs through the bypass orifice which is located below the thermostat. No coolant is allowed to enter the radiator.

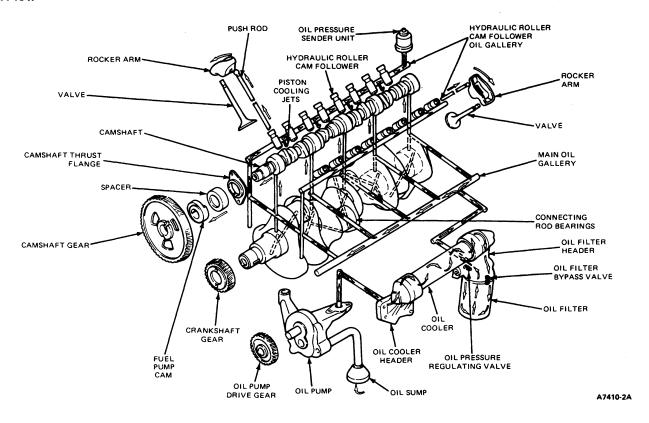
When the coolant reaches 89°C (192°F) the thermostat begins to open. At the same time, the bottom of the thermostat moves closer to the bypass opening. The volume of coolant allowed to bypass is decreased, and coolant is permitted to circulate through the radiator. The thermostat is fully open at 100°C (212°F). Refer to Section 36-25, Heater and Ventilation System,—F-250-F-350 or Section 36-23, E-250—E-350 Hi-Output Heating System for heater hose routing. Refer to the engine front and LH side view for coolant temperature sender, heater supply, heater return, and coolant drain locations.



### **Lubrication System**

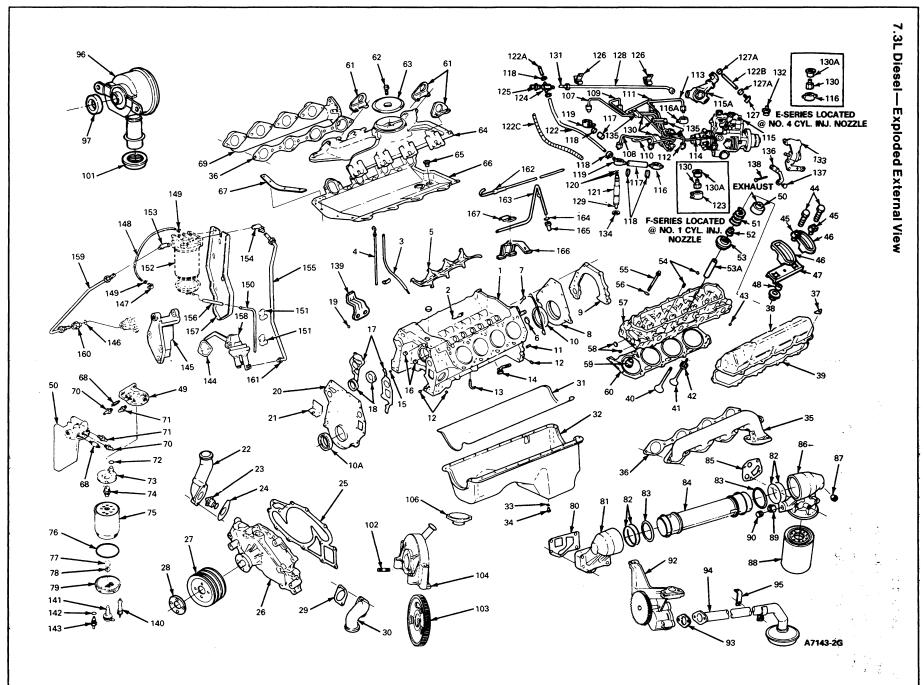
Lubrication oil is drawn out of the sump through the pick up screen and oil pick up tube to the oil pump. Oil pump flow is 45.4 liters (12 gallons) per minute at rated speed and a pressure of 275-482 kPa (40-70 psi). From the oil pump, oil is passed through drilled passageways in the crankcase to the oil cooler header, then through the oil cooler. Oil flows around the outside of the heat exchanger tubes. (Coolant flows through the tubes). The oil passes from the oil cooler to the oil filter header. At the oil filter header, the oil meets the pressure regulating valve. The oil pressure regulator valve controls the volume and pressure of filtered oil supplied to the engine. The rear oil filter header also incorporates a bypass valve which opens if the oil filter becomes clogged. Five cross passages distribute oil to vertical passages which feed crankshaft main bearings, camshaft bearings and two tappet galleries. The piston cooling jets are fed from the same passage as the valve tappets. The connecting rod bearings are fed from the main bearings through drilled passages in the crankshaft. The timing gears are lubricated by oil splash. Oil passes through the hydraulic tappet rollers and up the hollow push rods to lubricate the rocker arm assemblies and valve stems.

### Oil Flow



### **Engine Components**

Refer the following exploded views and indices when performing procedures in this Section. Part descriptions and part numbers listed in the keys correspond with the Ford Master Parts Catalog.



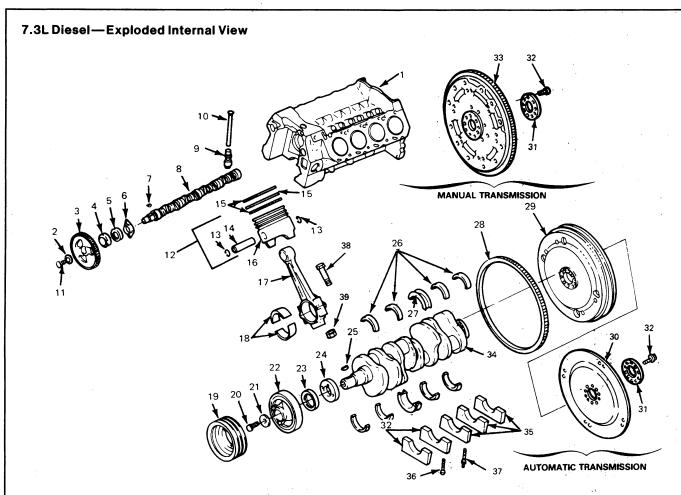
: • • •

# DESCRIPTION AND OPERATION (Continued)

# 7.3L Diesel—Exploded External View-Key

| REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                       | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                        | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                     | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                         |
|-------------|-------------------|-----------------------------------|-------------|-------------------|------------------------------------|-------------|-------------------|---------------------------------|-------------|-------------------|-------------------------------------|
| 1           | .6009H            | Cylinder Block Assy.              | 45          |                   | Post, Valve Lever                  | 89          |                   | Plug, 1/2 Inch                  | 132         | 9E939             | Temperature Switch                  |
| 2           | 6C329A            | Guide, Tappet                     | 46          | 1                 | Lever, Valve                       | 90          | 1,00              | Plug, 1/2 Inch                  | 133         | 12B526            | Bracket and Solenoid-Fast Idle      |
| 3           | 6754              | Tube Assembly, Oil Level Gauge    | 47          |                   | Retainer, Valve Lever Post         | - 92        | 6600              | Oil Pump Assy.                  | 134         |                   | Gasket Nozzle (8)                   |
| _ 1         |                   | (F-Senes)                         | 48          | -                 | Lock, Valve Spring Retainer        | 93          | 6626              | Gasket, Oil Pick-Up             | 135         | 9N653             | Clamp                               |
| _4          | 6750              | Oil Level Gauge (F-Series)        | 49          | 6514A             | Retainer, Valve Spring (36)        | 94          | 6622              | Pick-Up Tube                    | 136         | 9F541             | Kickdown Lever (Auto. Trans.)       |
| 5           | 6C330A            | Retainer, Tappet Guide            | 50          | -                 | Shield, Oil (Exhaust)              | 95          | 6A661             | Bracket, Oil Pick-Up            | 137         | 9D927             | Screw, Kickdown Lever               |
| 6           | 6026A             | Plug, Engine (1-1/2" O.D.)        | <b>'51</b>  | 6513B             | Spring, Valve, with Damper (16)    | 96          | 6A665             | COR Valve                       | 138         | 9F539             | Adjusting Screw (Kickdown Lever)    |
| 7           | 6D083A            | Gasket, Rear Cover                | 52          | 6571A             | Seal, Valve Stem-Intake (8)        | 97          | 6A892             | Seal Ring, CDR Valve            | 139         | 6786              | Bracket, Oil Level Tube Support     |
| 8           | 6L080A            | Cover Assembly, Engine, Rear      | 53          | 6K533A            | Rotator, Assembly Valve (16)       | 100         | 6758              | Crankcaise Vent Tube            | . *         | · .               | (F-Series)                          |
| 9           | 6A369A            | Adapter, Flywheel to Transmission | 53A         | <u> </u>          | Guide, Valve (Service)             | 101         | 6769              | Grommet, Valley Cover           | 140         | 5 1               | Vent/Valve Assembly                 |
| 10          | 6701A             | Rear Oil Seat, Crankshaft         | 54          |                   | Plug, 1/2 inch NPTF (4)            | 102         | 9F733             | Mounting Stud, Injection Pump   | 141         |                   | Manual Drain Valve                  |
| 10A         |                   | Front Oil Seal                    | 55          | 6065A             | Bolt Cylinder Head (34)            | 103         | 9A546             | Drive Gear, Injection Pump      | 142         |                   | Water Sensor O-Ring                 |
| 11          | 6B041B            | Dowel Pin, Fly Wheel Adapter      | 56          | : 6L015A          | Washer, Cylinder Head Bolt (34)    | 104         | , 9C516           | Adapter Housing, Injection Pump | 143         | *                 | Water Sensor Probe                  |
| 12          | 876148            | Pipe Plug, 1/8 NPTF               | 57          | 6049A             | Cylinder Head Assembly (2)         | 106         | 6766              | Cap, Oil Filler                 | 144         |                   | Fuel Pump Supply Gasket             |
| 13          | 6C327A            | Piston Cooling Jet                | 58          | 6026B             | Plug, 1/4 Inch                     | 107         | 9A555H            | Pipe w/Nuts Pump to Cyl. 8      | 145         |                   | Alternator Bracket                  |
| 14          | 6A051A            | Heater Assembly, Block            | -59         | 6057A             | Insert, Combustion Chamber (8)     | 108         | 9A555G            | Pipe w/Nuts Pump to Cyl. 7      | 146         | . 3               | Sealing O-Ring                      |
| 15          | 6B041A            | Dowel Pin, Front Cover Plate      | 60          | 6051B             | Gasket, Cylinder Head+(2)          | 109         | 9A555F            | Pipe w/Nuts Pump to Cyl. 6      | 147         |                   | Fuel Return Tee (At Nozzle)         |
| 16          | 6026E             | Cup Plug                          | 61          |                   | Eye, Lifting (3)                   | 110         | 9A555E            | Pipe w/Nuts Pump to Gyl. 5      | 148         |                   | Hose, 3/16" ID x 10" Long           |
| 17          | 6020A             | Gasket, Front Cover Plate         | 62          | 9C629A            | Insert, Bolt Thread-Air            | 1115        | 9A555D            | Pipe w/Nuts Pump to Cyl. 4      | 149         |                   | Hose Clip                           |
| 18          | 6A251A            | Bearing Kit, Camshaft             |             |                   | Cleaner Stud                       | 112         | 9A555C            | Pipe w/Nuts Pump to Cyl. 3      | 150         |                   | Water Drain Tube                    |
| 19          | 6A628A            | Ball, Oil Indicator Hole 11/32"   | 63          | 9F460A            | Screen, Intake Manifold            | 113         | 9A555B            | Pipe w/Nuts Pump to Cyl. 2      | 151         |                   | Drain Tube Clamp (Z)                |
| 20          | 68070À            | Plate, Front Cover                | 64          | 9424B             | Manifold, Intake                   | 114         | 9A555A            | Pipe w/Nuts Pump to Cyl. 1      | 152         |                   | Fuel Filter/Water Separator Element |
| 21          |                   | Indicator, Timing (Part of Front  | - 65        | 9A450A            | Drain Plug, Valley Pan             | 115         | 9A543             | Injection Pump                  | 153         |                   | Elbow:                              |
|             |                   | Cover)                            | 66          | 9439B             | Gasket and Valley Pan              | 115A        | ,                 | Valve, Vacuum Modufator         | 154         |                   | Elbow, Fuel Supply Pump to Filter   |
| 22          | 8592G             | Connection, Water Outlet          | 67          | 9B470A            | Strap, Valley Pan                  | 1           | ļ                 | (Auto. Trans:)                  |             |                   | Header                              |
| 23          | 8575              | Thermostat                        | 68          |                   | Fuel Priming Valve and Cap         | 116         |                   | Fuel Return Tee                 | 155         |                   | Fuel Pump to Fuel Header Tube       |
| 24          | 8255A             | Gasket, Water Outlet              | 69          | 9430A             | Manifold, Exhaust, Right           | 116A        | ``\- <u>-</u> ,   | Elbow, Fuel Return (F-Series)   |             |                   | (With Two Nuts and Two Sleeves)     |
| 25          | 8507A             | Gasket, Water Pump                | 70          |                   | Continuous Vent with Check Valve   | 117-        | _                 | Hose                            | 156         | 2                 | Hose, 3/16" x 2-5/16" Long          |
| 26          | 8501D             | Water Pump                        | 71          |                   | Vacuum Switch (Fuel Filter Element | 118         | 98255             | Clip                            | 157         |                   | Fuel Filter Header Mounting Bracket |
| 27          | 8509D             | Pulley, Water Pump                |             |                   | Replacement Indicator)             | 119         | 9A564             | Fuel Return Tee                 | 158         |                   | Fuel Supply Pump                    |
| 28          | 8546A             | Spacer, Fan                       | 72          |                   | Fuel Heater Q-Ring                 | 120         | 87032-S92         | O-Rings                         | 159         |                   | Filter to Injection Pump Tube (With |
| 29          | 8255A             | Gasket, Water Inlet               | 73          |                   | Fuel Heater                        | 121         | 9E527             | Injection Nozzle Holder         |             |                   | Two Nuts and Two Sieeves)           |
| 30          | 8592D             | Connection, Water Inlet           | 74          |                   | Threaded Insert                    | 122         | _                 | Fuel Return Hose                | 160         | 1                 | Connector Fitting                   |
| 31          | D6AZ-19562-A      | RTV Sealant                       | 75          |                   | Fuel Filter Element                | 122A        |                   | Hose                            | 161         |                   | Inverted, Flare Tube Nut            |
| 32          | 6675C             | Oil Pan                           | 76          |                   | Drain Bowl O-Ring                  | 122B        |                   | Hose, Pump to Fuel Return Tube  | 162         | <b>7</b> 5-       | Oil Level Gauge — E-Series          |
| 33          | 6734A             | Gasket, Oil Pan Drain             | . 77        |                   | Drain Valve Stem Cap               | 122C        |                   | Guard, Rear Fuel Return Hose    | 163         | 3                 | Tube Assembly, Oil Level Gauge —    |
| 34          | 6730A             | Plug, Oil Pan Drain               | 78          | F 1               | Drain Valve Seal                   | 123         |                   | Fuel Return Tee (E-Series)      |             | 15                | E-Series                            |
| 35          | 9431B             | Manifold, Exhaust, Left           | 79          |                   | Water Separator Drain Bowl         | 124         | 9F734             | Fuel Return Junction Fitting    | 164         |                   | O-Ring, Oil Level Gauge — E-Series  |
| 36          | 9448A             | Gasket Exhaust Manifold           | 80          | 6A636A            | Gasket, Oil Cooler, Front Header   | 125         | _                 | Nipple, Fuel Return             | 165         |                   | Oil Level Gauge Tube, Lower —       |
| 37          | 6A532A            | Washer, Valve Cover               | 81          |                   | Header, Oil Gooler, Front          | 126         | 9N659             | Clamp                           |             |                   | E-Series                            |
| 38          | 6582C             | Valve Cover                       | 82          | 6K649A            | O-Ring, Oil Cooler (2)             | 127         | 9F736             | Elbow                           | 166         |                   | Bracket, Oil Level Gauge Tube       |
| 39          | 6584A             | Gasket, Valve Cover               | 83          | 6C610A            | O-Ring, Oil Cooler (2)             | 127A        | -                 | Clip                            | 2           | a e               | E-Series                            |
| 40          | 6507D             | Valve, Intake (8)                 | 84          | 6A642A            | Cooler, Oil                        | 128         | 9D308             | Tube                            | 167         |                   | Retainer, Oil Level Gauge Tube -    |
| 41          | 6505              | Valve, Exhaust                    | 85          | 6A636B            | Gasket, Oil Cooler, Rear Header    | 129         | _                 | Nozzle Tip                      | ١.,         |                   | E-Series                            |
| 42          | 6057B             | Insert, Exhaust Valve Seat        | . 86.       | 6881B             | Header, Oil Cooler, Rear           | 130         | _                 | Sensor, Fuel Line Pressure      | · 1         |                   |                                     |
| 43          | 6026F             | Plug, Ball Type 13/32" (8)        | 87          | 6K862A            | Plug, 1/4-inch                     | 130A        |                   | Cover                           | , n         |                   |                                     |
| 44          |                   | Bolt. Valve Lever and Washer      | 88          | 6731A             | Oil Filter _:                      | 131         | 9C387             | Sleeve Seal, Fuel Return (2)    |             |                   |                                     |

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| REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                       | REF.<br>NO. | BASIC<br>PART NO. | DESCRIPTION                              |
|-------------|-------------------|-----------------------------------|-------------|-------------------|--|
| 1           | ,6009H            | Cylinder Block Assembly           | 21 ,        | 6278B             | Washer, Crankshaft                       |
| 2           | 6278A             | Washer, Camshaft                  | 22          | 6379A             | Damper, Crankshaft                       |
| 3           | 6256A             | Gear, Camshaft                    | 23          | 6700A             | Seal, Crankshaft Front Oil               |
| 4           | 6287A             | Eccentric, Fuel Pump              | 24          | 6306A             | Gear, Crankshaft Drive                   |
| 5           | 6265A             | Spacer, Camshaft Gear             | 25          | 6B316A            | Key, Crankshaft Alignment                |
| 6           | 6269A             | Camshaft Thrust Plate             | 26          | 6333A             | Bearng, Crankshaft                       |
| 7           | 6L269A            | Key, Camshaft Alignment           | 27          | 6337A             | Bearing, Crankshaft Thrust               |
| 8           | 6250B             | Camshaft                          | 28          | 6384A             | Ring Gear, Flywheel                      |
| 9           | 6500A             | Roller Tappet                     | 29          | -                 | Flywheel — Automatic Transmission        |
| 10          | 6565A             | Push Rod                          | 30          | <u> </u>          | Flex Plate — Automatic Transmission      |
| 11          | 6K252A            | Bolt, Camshaft Drive Gear         | 31          | · . —             | Reinforcement Ring                       |
| 12          | 6108G             | Set, Piston, Pin                  | 32          | 6379A             | Bolt, Flywheel to Crankshaft             |
| 13          | 6140A             | Retainer, Piston Pin              | 33          | 6477              | Flywheel Dual Mass — Manual Transmission |
| 14          | 6135B             | Piston Pin                        | 34          | 6303A             | Crankshaft (with Bearings)               |
| 15          | 6148D             | Piston Rings                      | 35          |                   | Bearing Cap (Part of Cyl. Block Assy.)   |
| 16          |                   | Piston (Not Available Separately) | 36          | 6345A             | Bolt, Bearing Cap                        |
| 17          | 6200A             | Connecting Rod                    | 37          | 6345B             | Stud, Bearing Cap                        |
| 18          | 6211A             | Bearing Kit, Connecting Rod       | 38          | 6214A             | Bolt, Connecting Rod                     |
| 19          | 6A312A            | Pulley, Crankshaft                | 39          | 6212A             | Nut, Connecting Rod                      |
| 20          |                   | Bolt, Hex Head                    |             |                   |  |

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#### **Fuel Flow**

Fuel from the tank is routed to the fuel supply pump which pumps fuel through a combination fuel filter, heater and water separator. The filter header contains a continuous vent (orifice bleed off system) which aids starting by eliminating the need to manually prime the fuel filter. A vacuum switch is incorporated into the fuel filter header which will activate an instrument panel lamp, indicating the need for filter replacement. The water separator portion of the filter assembly has a probe which activates an instrument panel lamp when the filter requires draining at the water and sediment drain (located on the bottom of the assembly).

# WARNING: USE MOTORCRAFT® FUEL FILTER/WATER SEPARATOR FD-829 OR EQUIVALENT.

Fuel enters the inlet of the injection pump and is delivered under high pressure through injection nozzles into the engine cylinders for combustion. Each nozzle incorporates a fuel return fitting that returns excess fuel to the fuel tank. Excess fuel from the injection pump and each injection nozzle is collected in bleed off lines and returned to the fuel tank.

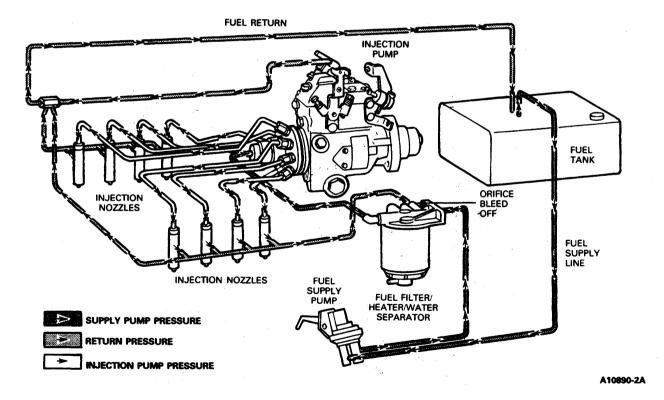
Injection nozzles are located on the inboard side of the cylinder head. This configuration has the following advantages:

- Injection nozzles operate in a cooler environment far removed from the exhaust manifold and exhaust ports.
- Injection lines do NOT interfere with engine accessories and provide better access to the engine for servicing.

Proper filtration of diesel fuel cannot be overemphasized. It is essential for long component life and reliability.

The Fuel Shut-Off solenoid controls the flow of fuel into the injection pump charging circuit (high pressure). With the ignition switch in START or RUN, the solenoid is energized and fuel is allowed to flow to the injection pump charging circuit. With the ignition switch OFF, fuel flow to the injection pump charging circuit stops.

#### **Fuel Flow**



#### **Injection Pump**

The diesel fuel injection pump accurately meters and delivers fuel to a nozzle in each cylinder at high pressure and at precisely timed intervals.

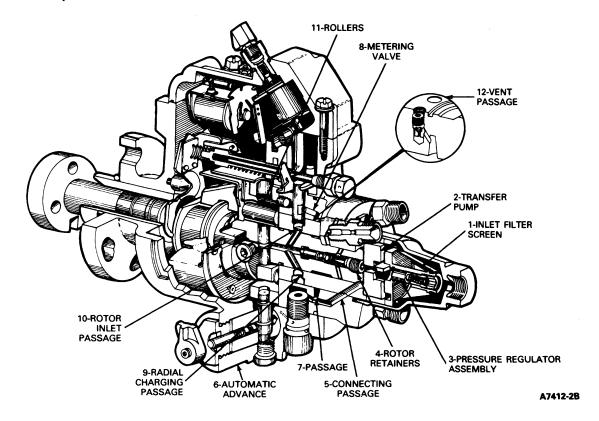
The injection pump is an opposed plunger, inlet metered, positive displacement, distributor type pump. The pump incorporates a single pumping chamber, an integral fuel transfer pump and governor, and an automatic injection advance mechanism. On-off control is provided by means of an electric solenoid located in the housing cover.

Operating principles of the pump can be understood by following the fuel circuit through a complete pump cycle. Fuel flows into the injection pump inlet through an inlet filter screen (1). Fuel then flows to the vane-type fuel transfer pump (2). Excess fuel from the transfer pump is bypassed through the pressure regulator assembly (3) to the suction side.

Fuel under transfer pump pressure flows through the center of the transfer pump rotor, past the rotor retainers (4) into the hydraulic head. It then flows through a connecting passage (5) in the head to the automatic advance (6) and up through a radial passage to the metering valve (8). The position of the metering valve, controlled by the governor, regulates fuel flow into the radial charging passage (9) which incorporates the head charging ports. As the rotor revolves, the two rotor inlet passages (10) align with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of alignment and the discharge port of the rotor aligns with one of the head outlets. While the discharge port is opened, the rollers (11) contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

In addition, an air vent passage (12) in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to be bled back to the fuel tank through the return line. Fuel bypassed in this way fills the housing, lubricates the internal components, cools and carries off any small air bubbles.

#### **Injection Pump Internal View**



#### **Injection Nozzle Assemblies**

#### **Description**

The injection nozzles are of the inwardly opening, differential, hydraulically operated, pintle-type. Their function is to direct a metered amount of fuel, under high pressure from the fuel injection pump, into the engine combustion chamber.

The injection nozzle assembly consists of two sub-assemblies; the nozzle and the nozzle holder.

#### **Nozzle Holder**

The nozzle holder retains the nozzle in its correct position in the cylinder head and provides channels for conducting diesel fuel to the nozzle.

#### Nozzle

The nozzle consists of two parts; nozzle body and nozzle valve. These parts are lapped to form an extremely close-fitting matched set.

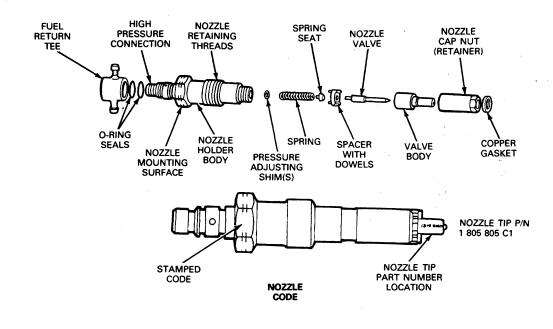
The nozzle valve carries an extension at its lower end, called the pintle, which protrudes through the closely fitting hole in the bottom nozzle face. This construction requires the fuel to pass through an annular orifice.

#### Operation

Operation of the injection nozzle assembly is simple and positive. A metered quantity of fuel from the injection pump enters the nozzle holder through the inlet fitting. It then passes through ducts to the pressure chamber located just above the nozzle valve seat. At the instant the pressure of fuel acting on the differential area of the valve exceeds a predetermined spring-load, it lifts the valve from its seat and fuel flows from the nozzle until delivery from the injection pump ceases. Positive cut-off of fuel occurs as the valve is seated by the nozzle spring. A small amount of fuel leakage to the spring cavity is necessary for lubrication. This fuel leakage accumulates in the spring cavity and drains through to a leak-off outlet provided for this purpose.

Nozzle opening pressure and spray pattern should be inspected every 96,500 km (60,000 mi.). Refer to Nozzle Testing in the Engine / Emissions Diagnosis Manual.\*

#### **Injection Nozzle Assembly**



#### **Glow Plug Fast Start System**

The 7.3L diesel engine utilizes a solid-state glow plug system to aid in the start of the engine. The system pre-heats air in the combustion chamber to aid ignition of the fuel.

The system consists of eight glow plugs (one for each cylinder), a solid-state glow plug controller/power relay assembly, two fusible links located between the power relay and the glow plug harness (one for each bank of four glow plugs), WAIT TO START lamp and a wiring harness which incorporates eight fusible wires (one for each glow plug).

During initial start with cold engine, the glow plug system operates as follows:

A10688-2A

When the ignition switch is turned to RUN, voltage is applied through the glow plug controller to the glow plug power relay. The contacts in the relay close, and voltage is applied to the WAIT TO START lamp and the glow plugs. The glow plugs are heated from zero to approximately 15 seconds, depending upon engine temperature, then glow plug power relay voltage is cut off. This opens the relay contacts, turning off the GLOW PLUG indicator lamp and the glow plugs. The glow plugs are now warm enough for the engine to be started.

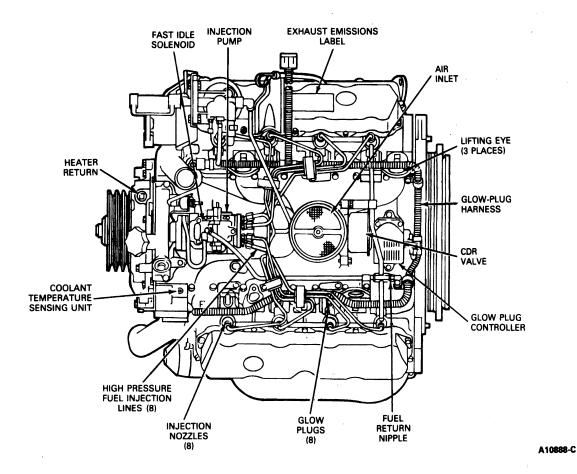
CAUTION: Hard starting will result if the ignition switch is left on for over two minutes without starting the engine. If the ignition switch is turned off, it can be turned on immediately and the glow plug heating cycle will start again.

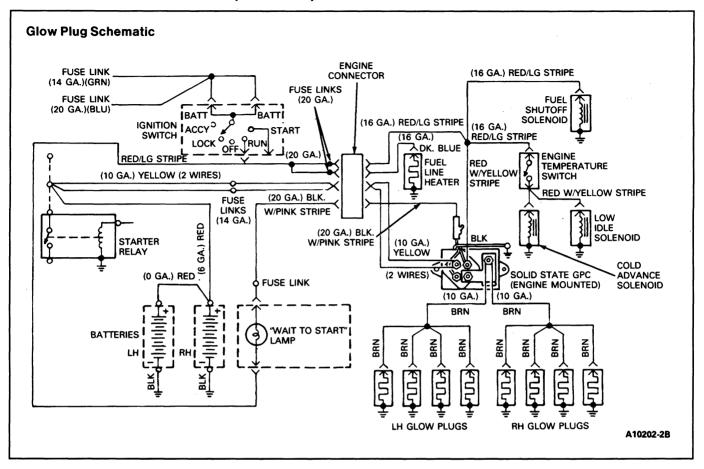
An after-glow operation allows the glow plugs to cycle on and off after the WAIT TO START lamp has turned off. This helps to reduce white smoke during engine warm-up. The lamp will **NOT** cycle on and off during this operation.

The solid-state system determines the glow plug temperature by electronically measuring the resistance of the glow plugs and maintains temperature regardless of ambient conditions. The system uses positive temperature coefficient (PTC) glow plugs with push-on bullet terminals. These are **NOT** interchangeable with previous model year glow plugs.

CAUTION: Never bypass the power relay of the glow plug system. Constant battery current (12 volts) to glow plugs will cause them to overheat and fail, possibly resulting in severe engine damage.

#### **Glow Plug Engine Harness**





### **Dual Mass Flywheel (Manual Transmission Only)**

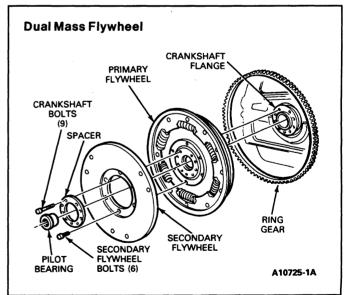
The flywheel assembly used on the 7.3L-V-8 diesel engine is known as a dual mass flywheel. The purpose of the dual mass flywheel is to provide one inertia mass connected directly to the engine crankshaft and a second inertia mass connected through the clutch system to the transmission. The dual mass flywheel provides the same functions as the conventional flywheel with mounting surfaces for the starter ring gear, clutch pilot bearing and clutch pressure plate and the friction surface for contact with the clutch disc.

The first inertia mass provides sustaining energy to maintain engine operation between the times that the cylinders fire and to maintain smooth power delivery.

The second inertia mass provides sustaining energy to the transmission for smooth, quiet transfer of power to the rear wheels.

Positioned between these two inertia masses is a series of springs and friction elements to provide smooth, quiet operation and a torque limitation function to protect the drivetrain from impact shock.

Another internal dual mass flywheel component is the central double row ball bearing used to mount the second inertia mass onto the first inertia mass. This bearing is designed for long life and requires no lubrication.

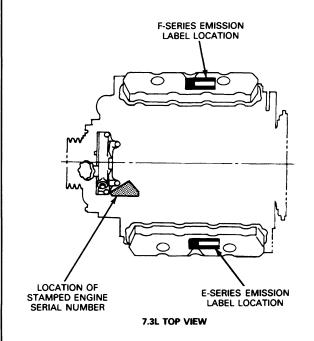


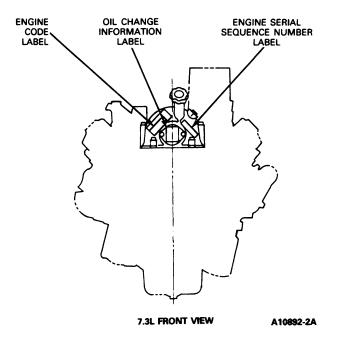
#### **Vehicle and Engine Identification**

Vehicle identification, the location of the vehicle rating and data plates and engine code information is fully covered in Section 20-00, Identification Codes. For specific and exact engine identification an engine code label is affixed to the gear tower. Refer to the illustrations for examples of engine identification labeling.

Always refer to the engine code label when replacement parts are required or when checking engine calibrations. Some engine parts vary with engine application and vehicle type. The identification codes will ensure that the proper parts are obtained. The codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application. Additional identification information can be found in the permanent engine serial number (stamped on the front side of the crankcase) the emission label (affixed to the valve cover), or the engine serial sequence number label or oil change information label (near the engine code label on front of engine).

#### **Engine Identification**





### **Engine Code Label**

#### **ENGINE SERIAL NUMBER CHART**

| ENGINE<br>DISPLACEMENT | VARIATION<br>CODE | COUNTRY<br>OF ORIGIN | SERIAL<br>SEQUENCE<br>NUMBER |
|------------------------|-------------------|----------------------|------------------------------|
| 7.3                    | DU2               | U .                  | 500001*                      |

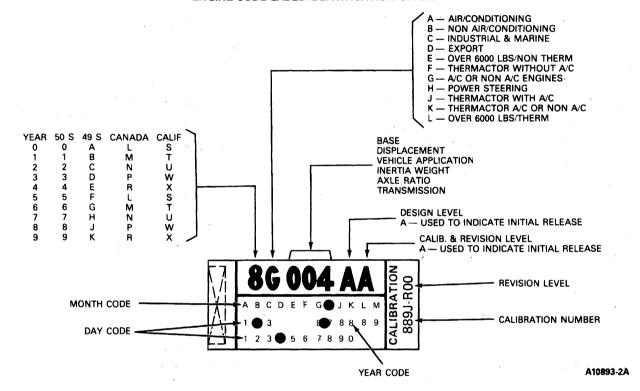
7.3 Engine Displacement in Liters

D = Naturally Aspirated U2 = OEM Application

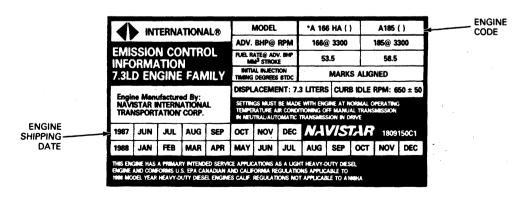
U = Country of Origin - U.S.A.

000501 = Starting Sequence Number \* = Used to Prevent Tampering

#### **ENGINE CODE LABEL IDENTIFICATION CHART**



#### **Engine Emission Label**



A10689-2A

#### **DIAGNOSIS AND TESTING**

### Diagnostic Procedures—Engine Components Engine Oil Leaks

When diagnosing engine oil leaks, the source and location of the leak must be positively identified before any repairs are made. Prior to using this procedure, it is important to clean the cylinder block, cylinder head(s), valve cover(s), oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil

# CAUTION: Do not wash or steam clean the engine with engine running. Serious damage to the injection pump could result.

To perform oil leak diagnosis use Oil Leak Detector Rotunda Model 112-00001, or equivalent.

# CAUTION: Do not use an air pressure leak test kit for diagnosing engine oil leaks. Loss of sealing may result at the valley pan seal.

To perform oil leak diagnosis use Oil Leak Detector Rotunda Model 112-00001, or equivalent.

 Open two containers of dye by cutting off end of spout and empty entire contents of containers into crankcase.

# CAUTION: Dye may cause irritation. Avoid contact with skin or eyes. Wash thoroughly after handling.

- Drive vehicle for five to ten miles at various road speeds.
- Turn on spot lamp. (Lamp requires 3-5 minutes to warm up).
- Open hood. Remove air cleaner and install intake manifold cover, using Intake Manifold Cover T83T-9424-A or equivalent, over intake manifold opening.
- Inspect sealed and/or gasketed areas for leaks with the spot lamp. A leak will appear as a bright contrasting yellow-green fluorescence. Examine the following areas, as required:

#### Leak Test Kit Rotunda Model 112-00001



A7911-1A

#### **Under Hood**

- a. Valve cover gaskets and around bolts.
- b. Crankcase front cover gaskets.
- c. Front and rear valley pan end seals.

- d. Cylinder head gaskets.
- e. Injection pump mounting adapter to crankcase.
- f. Injection pump to adapter.
- g. Front oil fill tube and oil fill cap.
- h. Fuel supply pump and / or mounting gasket.
- i. Oil pressure sending unit.
- j. Cup plugs and / or pipe plugs at the end of oil passages.

#### Under Engine — With Vehicle on Hoist

- a. The complete oil pan perimeter.
- b. Crankcase front cover gaskets.
- c. Front crankshaft seal.
- d. Oil filter seal.
- e. Oil cooler mounting gaskets and header O-rings.
- f. Fuel supply pump and / or mounting gasket.
- g. Oil level indicator (dipstick) tube connections.

#### With Transmission Removed

a. Flywheel mounting bolts.

### With Transmission and Flywheel Removed and Flywheel Mounting Bolt Holes Plugged

- a. Rear crankshaft seal.
- Rear cup plugs and / or pipe plugs.
- c. Rear cover gasket.
- d. Rear cover oil pan seal.

NOTE: Install specified sealant on flywheel bolts and install flywheel as outlined in this Section.

#### Oil Cooler Internal Leakage Test

When oil is found in the cooling system or coolant in the oil, the oil cooler assembly should be inspected for leakage.

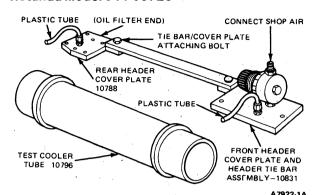
Areas of possible leakage are:

- O-rings
- Oil Cooler Bundle (Tubes)
- Front Header
- Rear Header

Clean the cooling system if oil is found in the coolant. Refer to Section 03-03, Engine Cooling. If coolant is found in the oil, change engine oil and filter.

- Remove oil cooler assembly from engine with filter installed as outlined in this Section.
- Inspect the gaskets at the header flanges for leakage of coolant into the oil or oil into the coolant.
- Using new header gaskets, assemble Rotunda Oil Cooler Internal Leakage Tester 014-00726 or equivalent, to the engine oil cooler by bolting the cover plate to the rear header, bolting the cover plate and tie bar assembly to the front header and bolting the tie bar to the rear header cover plate.

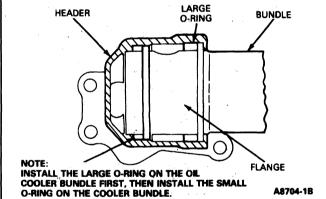
#### Oil Cooler Internal Leakage Test Equipment Rotunda Model 014-00726



NOTE: Use original oil cooler tube and NOT test cooler tube included with Rotunda model 014-00726 Oil Cooler Internal Leakage Tester, or equivalent.

NOTE: Install the large O-ring on the oil cooler bundle first, then install the small O-ring on the cooler bundle.

#### Oil Cooler Tube Installed in Header



- Pressurize coolant side of front header test plate (adapter A) at air supply fitting with 276.8 kPa (40 psi) air pressure.
- Check for air leakage at the plastic tube or each header cover plate. If air leakage is not felt, place a cup of water up to the plastic tubes and look for bubbles. There should be no bubbles for a one-minute time period.

NOTE: If no leakage is observed, the complete oil cooler assembly (headers, O-rings and cooler bundle tube) **DOES NOT** have an internal leak. Install the oil cooler assembly to the engine as outlined in this Section. Continue engine diagnostic procedures to identify the source of the leak.

NOTE: Steps 3 through 5 may also be used as a functional test of a newly overhauled oil cooler assembly.

- If air leakage is observed, unbolt the test kit tie bar and remove the front and rear headers from the cooler bundle (with cover plates attached to headers). Replace the four cooler bundle O-rings.
  - NOTE: Install the large O-ring on the oil cooler bundle first, then install the small O-ring on the cooler bundle.
- Bolt the test kit tie bar to the rear header cover plate. Repeat steps 4 and 5 with the cooler assembly submerged in water. If leakage persists, isolate the worn or damaged component in the oil cooler assembly, as follows:
  - For a leaking oil cooler still covered by warranty (3 yrs., 80.450km or 50,000 miles) go to step 8.
  - B. For a leaking oil cooler not covered by warranty go to step 10.
- 8. For a leaking oil cooler covered by warranty, replace and retest the following oil cooler components in the following sequence until no leakage is observed:
  - a. Front header
  - b. Rear header
  - c. Cooler bundle (tube)

NOTE: Prior to each retest, inspect the condition of the affected header gasket(s) and O-rings and replace if damaged.

- Assemble the affected test kit cover plate(s) and tie bar. Repeat steps 4 and 5 with cooler assembly submerged in water. If leak persists, replace the next component listed in step 8. If no leakage was observed, go to step 12.
- For a leaking oil cooler not covered by warranty, replace and test the following oil cooler components in the following sequence until no leakage is observed:
  - a. Cooler bundle (tube)
  - b. Front header
  - c. Rear header

NOTE: Prior to each retest, inspect the condition of the affected header gasket(s) and O-rings, replace if damaged.

- 11. Assemble the affected test kit cover plate(s) and tie bar. Repeat steps 4 and 5 with cooler assembly submerged in water. If leak persists, replace the next component listed in step 8. If no leakage was observed, go to step 12.
- Install oil cooler assembly onto engine with new gaskets as outlined.

NOTE: Clean the cooling system if oil is found in the coolant. Refer to Section 03-03, Engine Cooling. If coolant is found in the oil, change the oil and filter.

#### **Compression Test**

The following procedure is to be used when checking compression:

- Ensure battery is fully charged. Operate the engine until normal operating temperature is attained. Turn the ignition switch to OFF. Remove air cleaner and/or intake opening cover using Intake Manifold Cover T83T-9424-A or equivalent. Disconnect injection pump solenoid leads from injection pump to prevent accidental engine starting. Remove all glow plugs.
- Install Rotunda Compression Tester 014-00701 or equivalent in No. 1 cylinder glow plug hole.
- Crank the engine (with the ignition switch OFF) at least five pumping strokes. Record highest reading indicated. Note the approximate number of compression strokes required to obtain the highest reading.
- Repeat the check on each cylinder, cranking the engine approximately the same number of compression strokes.

#### **Test Conclusion**

Compression pressures are considered normal if the lowest reading cylinder is within 75 percent of the highest. Variations exceeding 75 percent indicate an improperly seated valve or worn or broken piston rings.

CAUTION: Do not add oil to cylinder. This could cause hydrostatic lock.

#### **Compression Test Pressures**

| HIGHEST CYLINDER     | LOWEST CYLINDER      |  |
|----------------------|----------------------|--|
| Maximum<br>kPa (PSI) | Minimum<br>kPa (PSI) |  |
| 1792 (260)           | 1344 (195)           |  |
| 1929 (280)           | 1447 (210)           |  |
| 2067 (300)           | 1551 (225)           |  |
| 2205 (320)           | 1654 (240)           |  |
| 2343 (340)           | 1757 (255)           |  |
| 2481 (360)           | 1860 (270)           |  |
| 2619 (380)           | 1964 (285)           |  |
| 2756 (400)           | 2067 (300)           |  |
| 2894 (420)           | 2171 (315)           |  |
| 3032 (440)           | 2274 (330)           |  |

CA7414-1B

#### **Hydraulic Valve Tappet**

Hydraulic tappet noise may be caused by any of the following:

- Excessive collapsed tappet gap.
- 2. Sticking tappet plunger.

- Tappet check valve not functioning properly.
- 4. Air in lubrication system.
- 5. Leakdown rate too rapid.
- 6. Excessive valve guide wear.

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts, or wear of tappet roller, push rod, rocker arm, rocker arm fulcrum or valve tip. Using Tappet Bleed-Down Wrench T83T-6500-A or equivalent, collapse tappet and check gap between valve tip and rocker arm to determine if any valve train parts are damaged, worn, or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. Sticking plungers can sometimes be serviced by disassembling the tappet and removing the dirt, chips or varnish causing the condition.

A non-functional tappet check valve may be caused by an obstruction (dirt or chips) preventing it from closing when the cam lobe is lifting the tappet. Non-functional tappet check valves may also be caused by a broken check valve spring.

Air bubbles in the lubrication system prevent the tappet from supporting the valve spring load. Bubbles may be caused by too high or too low an oil level in the oil pan, by air being drawn into the system through a hole or crack, or a leaking gasket on the oil pump pickup tube.

If leakdown time is below specifications for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, check leakdown rate and replace any outside the specification.

Check leakdown rate of assembled tappets with Hydraulic Tappet Leakdown Tester TOOL-6500-E or equivalent. The leakdown rate specification is the time in seconds the plunger requires to move a specified distance of its travel while under a 22.68 kg (50 lb) load. Test the tappets as follows:

 Disassemble and clean tappet to remove all traces of engine oil.

NOTE: Do not mix parts from different tappets.

Parts are select-fitted and are **NOT** interchangeable.

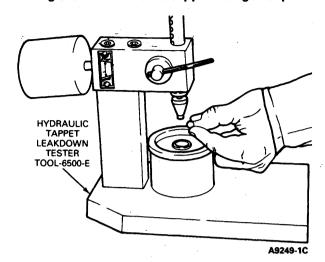
Tappets cannot be checked with engine oil in them. Only testing fluid can be used.

 Place the tappet in tester, with plunger facing upward. Pour hydraulic tappet tester fluid into the cup to a level that will cover tappet assembly. The fluid can be purchased from the manufacturer of the tester.

NOTE: Using kerosene or any other fluid will not provide an accurate test.

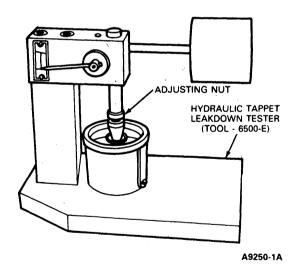
Place the 5 / 16-inch steel ball provided with tester into the plunger cap.

#### Placing Steel Ball in Valve Tappet Plunger Cap



4. Adjust ram length so that the pointer is 1.59mm (1/16 inch) below the starting mark when ram contacts tappet plunger, to facilitate timing as the pointer passes the Start Timing mark. Use center mark on the pointer scale as Stop Timing point instead of original Stop Timing mark at top of scale.

#### **Adjusting the Ram Length**



- Work the tappet plunger up and down until tappet fills with fluid and all traces of air bubbles have disappeared.
- Allow ram and weight to force tappet plunger downward. Measure the exact time it takes for the pointer to travel from Start Timing to Stop Timing marks of tester.

- 7. A satisfactory tappet must have a leakdown rate (time in seconds) within the minimum and maximum specified limits. Refer to Specifications in this Section for tappet leakdown rate.
- If tappet leakdown is not within specifications, replace it with a new tappet. It is not necessary to disassemble and clean new tappets before testing, because the oil contained in new tappets is test fluid.
- Remove fluid from cup and bleed fluid from tappet by working plunger up and down. This step will ease depression of tappet plungers when checking valve clearance.

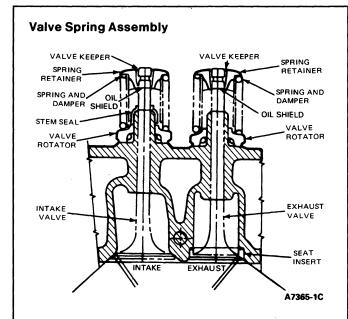
### Static (Engine Off) Valve Train Analysis Rocker Arm Cover Removal

- Remove air cleaner and install intake opening cap using Intake Manifold Cover T83T-9424-A, or equivalent.
- Remove engine oil dipstick tube fasteners. Remove dipstick, tube assembly and rocker arm cover bracket.
- Remove rocker arm cover bolts.
- Remove rocker arm cover.

#### Valve Train Analysis

Check for damaged and/or severely worn parts, for correct assembly and use of correct parts by proceeding, as follows, with the static engine analysis.

- Rocker Arm Assemblies
  - a. Check for loose mounting bolts.
  - b. Check for plugged rocker arm oil hole.
- Push Rods: Check for bent push rods. Check for clogged passages.
- 3. Valve Spring Assembly—With Damper Spring: Check for broken or damaged parts.
- Retainer and Keys; Check for proper seating of keys on valve stem in retainer.
- Positive Valve Rotator: Check for proper seating of the positive valve rotator.
- 6. Valves and Cylinder Head
  - Check cylinder head gasket for proper installation.
  - b. Check for plugged oil drain holes.
  - c. Check for worn or damaged valve tips.
  - d. Check for missing or damaged valve stem oil seals.
  - e. Check collapsed tappet gap.



#### **Valve Cover Installation**

- Remove old gasket from cover. Scrape both valve cover rail on cylinder head and gasket flange on cover to remove all traces of old gasket, if necessary.
- 2. Install new gasket and install valve cover onto engine. Tighten bolts to specification.
- Install engine oil dipstick tube, valve cover bracket and cover. Tighten to specification. Install engine oil dipstick.
- Remove intake manifold cover. Install air cleaner and tighten to specification.

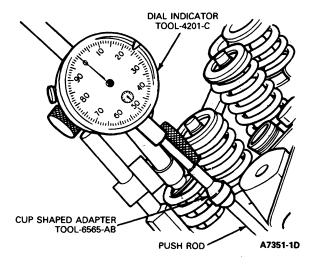
#### **Camshaft Lobe Lift**

Check lift of each lobe (in consecutive order) and make a note of readings.

- Remove fresh air inlet tube and air cleaner and install Intake Manifold Cover T83T-9424-A or equivalent.
- 2. Remove valve cover(s) as outlined.
- Remove fulcrum bolts, fulcrum seats and rocker arms as outlined.
- 4. Ensure push rod is in valve tappet socket. Install Dial Indicator D78P-4201-G and Dial Indicator Bracketry TOOL-4201-C or D78P-4201-F or equivalent, so that indicator ball socket adapter using Cup Shaped Adapter TOOL-6565-AB or equivalent, is on the end of the push rod and in the same plane as push rod movement.
- Rotate crankshaft by hand until tappet is on base circle of crankshaft lobe. At this point, push rod will be in its lowest position.

- NOTE: Remove glow plugs with Glow Plug Socket D83T-6002-A, or equivalent, to facilitate turning engine over by hand.
- Zero dial indicator. Continue to rotate crankshaft slowly until push rod is in fully raised position.
- Compare total lift recorded on indicator with specification.
- To check accuracy of original indicator reading, continue to rotate crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits, the camshaft and the valve tappet operating on the worn lobe(s) must be replaced.
- 9. Remove the dial indicator.
- Install rocker arms, fulcrum seats and fulcrum bolts as outlined. Tighten bolts to specification.
- Install the valve cover(s) as described in this Section. Tighten bolts to specification.
- 12. Remove intake manifold cover, install air cleaner and tighten to specification.

#### **Camshaft Lobe Lift Test**

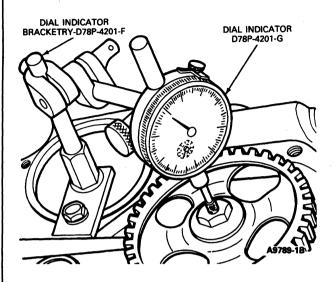


#### **Camshaft End Play**

Push the camshaft toward the rear of the engine. Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent, so that indicator point is on the camshaft gear attaching screw. Zero the dial indicator. Position a large screwdriver between the camshaft gear and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with specifications.

Remove the dial indicator. If end play is excessive, replace the camshaft thrust plate.

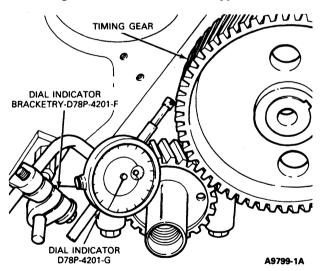
#### Check Camshaft End Play — Typical



#### **Drive Gear Backlash (All Gears)**

Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent, on the cylinder block. Check the backlash between the drive gear and the driven gear with a dial indicator at six equally spaced teeth. Hold the gear firmly against the block while making the check. Refer to Specifications for backlash limits.

#### Checking Drive Gear Backlash — Typical

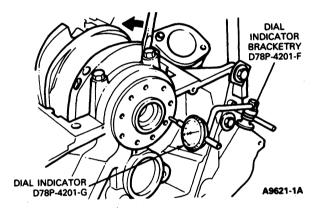


#### **Crankshaft End Play**

Force the crankshaft toward the rear of the engine.

- Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent, so that the contact point rests against the crankshaft flywheel flange and the indicator axis is parallel to the crankshaft axis.
- Zero the dial indicator. Push the crankshaft forward and note the reading on the dial.
- 4. If the end play exceeds specification, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If the thrust faces are not damaged or dirty, they probably were not aligned properly. Lubricate and install the thrust bearing and align the faces following the procedure recommended under Main Bearing Replacement. Check the crankshaft end play.

#### **Checking Crankshaft End Play**



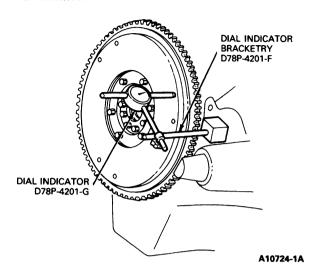
#### Flywheel Runout - Manual-Shift Transmission

NOTE: Remove glow plugs with Glow Plug Socket D83T-6002-A, or equivalent, to facilitate turning engine over by hand.

Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent, so that the indicator point bears against the flywheel face, one inch from the edge of the flywheel. Zero the dial indicator. Turn flywheel making sure it is fully forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If flywheel clutch face runout exceeds specifications, remove flywheel. Check for burrs between flywheel and face of the crankshaft mounting flange. If no burrs exist, check crankshaft mounting flange runout. If crankshaft mounting flange face runout is excessive, machine mounting flange or replace crankshaft. If crankshaft mounting flange runout is not excessive, reface or replace secondary flywheel. If the ring gear runout exceeds specifications, check installation of gear to flywheel flange. If it is not properly seated, re-install it to flywheel. If it is properly seated, replace it. Refer to Ring Gear Replacement in this Section for applicable procedures.

### Checking Flywheel Face Runout — Manual Transmission



#### Flywheel Runout — Automatic Transmission

Remove the glow plugs with Glow Plug Socket D83T-6002-A, or equivalent, to facilitate turning engine over by hand.

Install a dial indicator so that the indicator point rests on the ring gear face adjacent to the gear teeth.

Push the flywheel and crankshaft fully forward or rearward to prevent crankshaft end play from being indicated as flywheel runout.

Zero the dial indicator. Turn the flywheel one complete revolution while observing the total indicator reading (TIR). If TIR exceeds specifications, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. If crankshaft flange face exceeds specifications, machine mounting flange or replace crankshaft. If crankshaft flange face runout is not excessive, check installation of ring gear to flywheel. If not properly seated, remove and reinstall ring gear to flywheel. If ring gear is properly seated, replace flywheel.

### Diagnostic Procedures — Engine Performance and Glow Plug System

Diagnostic procedures for engine performance, fuel injection and glow plug fast start system are covered in the Engine / Emissions Diagnosis Manual\*. Injection pump timing and nozzle performance are also covered in the Engine / Emissions Diagnosis Manual\*.

#### **ADJUSTMENTS**

Refer to Engine / Emissions Diagnosis Manual\* for adjustment procedures.

#### REMOVAL AND INSTALLATION

When installing nuts or bolts that must be tightened, (refer to Torque Limits at the end of this Section), oil threads with light weight engine oil. **Do not oil** threads that require oil-resistant or water resistant sealer.

#### **Engine Assembly**

### F-250-F-350 F-Super Duty Chassis Cab-Stripped Chassis

#### Removal

- Disconnect battery ground cables from both batteries.
- Scribe alignment marks at hood hinges for reference during installation. Remove hood.
- 3. Drain cooling system. Refer to Section 03-03, Engine Cooling.
- 4. Remove air cleaner and intake duct assembly.
- Install Intake Manifold Cover T83T-9424-A, or equivalent, over air intake opening.
- 6. Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- Remove fan and clutch assembly as outlined, using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

### CAUTION: LH thread. Remove by turning nut clockwise.

- Disconnect radiator upper and lower hoses from radiator.
- Disconnect automatic transmission oil cooler lines at radiator, if so equipped.
- Remove radiator. Refer to Section 03-03, Engine Cooling.
- Loosen A / C compressor, if so equipped, and remove drive belt.
- Remove A/C compressor, if so equipped, and position it on radiator upper support (refer to Section 12-03A, A/C-Heater System F-150 through F-350 and Bronco—Manual).
- Loosen power steering pump and remove drive belt.
- Remove power steering pump and position out of the way on LH side of engine compartment.
- 15. Disconnect alternator wires at alternator.
- Disconnect oil pressure sending unit wire at sending unit located at back of engine.
- Disconnect accelerator cable from injection pump.
- Disconnect speed control cable from injection pump, if so equipped.

- Remove accelerator cable bracket (with cables attached), from intake manifold and position out of the way.
- Disconnect transmission kick down rod from injection pump, if so equipped.
- 21. Disconnect main wiring harness connector from RH side of engine.
- 22. Disconnect engine ground strap from rear of engine.
- 23. Disconnect fuel return hose from LH rear of engine.
- 24. Remove vacuum supply hose from vacuum pump, if so equipped.
- 25. Remove two upper transmission-to-engine attaching bolts.
- Disconnect heater hoses from water pump and right cylinder head.
- 27. Disconnect water temperature sender wire from sender on left front of engine block.
- Disconnect water temperature overheat lamp switch wire from switch on top front of left cylinder head.
- 29. Position wires out of the way.
- 30. Raise vehicle.
- 31. Disconnect both battery ground cables from lower front of engine.
- Disconnect and cap fuel inlet line at fuel supply pump.
- 33. Disconnect starter cables at starter motor.
- Disconnect muffler inlet pipe at exhaust manifolds.
- Disconnect engine insulators from No. 1 crossmember.
- 36. Remove flywheel inspection plate.
- Remove four converter-to-flywheel attaching nuts, if so equipped.
- 38. Lower vehicle.
- 39. Support transmission.
- Remove four lower transmission-to-engine attaching bolts.
- 41. Attach Rotunda Universal Load Positioning Sling 014-00036 or equivalent to engine.
- 42. Raise engine high enough to clear number one crossmember and pull forward.
- Rotate the front of the engine approximately 45 degrees to the left and lift it out of the engine compartment.

CAUTION: Use care not to damage windshield wiper motor when lifting engine out of vehicle.

#### Installation

NOTE: If the engine to be installed has been overhauled or has been in storage, take the following precaution to prevent piston and bearing scuffing. Prime the entire engine lubricating system to fill the oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.

- 1. Lower engine into engine compartment.
  - CAUTION: Use care not to damage windshield wiper motor when installing engine into vehicle.
- Start transmission main shaft into clutch disc. It
  may be necessary to adjust position of
  transmission in relation to engine if main shaft
  binds or will not enter clutch disc. If engine hangs
  up after main shaft enters clutch disc, rotate
  crankshaft slowly (transmission in gear) until
  mainshaft splines mesh with clutch disc splines.
- Align torque converter with flywheel studs, if so equipped.
- Lower engine onto engine insulator brackets on number one crossmember.
- Install four lower transmission-to-engine attaching bolts and tighten to specifications.
- 6. Remove engine lifting sling.
- Raise vehicle.
- Install four torque converter-to-flywheel attaching nuts, if so equipped, and tighten to specifications.
- Install flywheel inspection plate and tighten bolts to specifications.
- Install engine insulator support-to-crossmember bracket attaching nuts and washers and tighten to specifications.
- Connect muffler inlet pipes to exhaust manifolds and tighten nuts to specifications.
- Connect both battery ground cables to the lower front of the engine and tighten bolts to specifications.
- Connect starter cables to starter and tighten to specifications.
- Install fuel pump inlet line onto fuel pump and tighten to specifications.
- 15. Lower vehicle.
- 16. Connect water temperature sender wire to sender on left front of engine block.
- 17. Connect wire to water temperature overheat lamp switch on top of left cylinder head.
- Install heater hoses onto right cylinder head and water pump and tighten clamps to specifications.
- 19. Connect engine ground strap at rear of engine.
- 20. Connect fuel return hose at left rear of engine.
- 21. Connect vacuum supply hose to vacuum pump.

- 22. Connect transmission kickdown rod, if so equipped.
- 23. Install accelerator cable bracket onto intake manifold and tighten to specifications.
- 24. Connect accelerator cable to injection pump.
- Connect speed control cable, if so equipped, to injection pump.
- Connect oil pressure gauge sender wire to oil pressure sender.
- 27. Connect alternator wires to alternator.
- 28. Install power steering pump and drive belt. Do not adjust belt at this time.
- Install A/C compressor and drive belt. Refer to Section 12-03A, A/C Heater System F-150 through F-350 and Bronco—Manual in Body/Chassis/Electrical Manual.
- Adjust A / C compressor and power steering pump drive belts to specifications. Refer to Section 03-05, Belt Accessory Drive Service.
- Install radiator. Refer to Section 03-03, Engine Cooling.
- Connect automatic transmission oil cooler lines at radiator, if so equipped. Tighten line nuts to specifications.
- Connect upper and lower radiator hoses to radiator and tighten hose clamps to specifications.
- 34. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling.
- 35. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

### CAUTION: LH thread. Turn nut counterclockwise to tighten.

Tighten nut to specifications.

- Install radiator fan shroud. Refer to 03-03, Engine Cooling.
- 37. Remove intake manifold cover. Install air cleaner and tighten to specifications.
- 38. Install intake duct assembly.
- Install hood, aligning scribe marks drawn on hood during removal.
- 40. Connect battery ground cables at both batteries.
- 41. Check the engine oil level and fill as needed with specified type and grade of oil.
- 42. Run engine and check for fuel, oil and coolant leaks.

#### E-250-E-350

#### Removal

The engine removal and installation procedures are for the engine only (transmission not attached).

- 1. Remove engine cover.
- 2. Disconnect ground cables from both batteries.
- 3. Drain cooling system. Refer to Section 03-03, Engine Cooling.
- Remove front bumper, grille assembly and gravel deflector.
- 5. Remove speed control servo bracket and position out of way (if so equipped).
- Mark location and remove hood latch and cable assembly from grille upper support bracket.
- Remove upper grille support.
- Discharge the A/C system, if so equipped. Refer to Section 12-03B, A/C-Heater System -E-150—E-350, in Body/Chassis/Electrical Shop Manual.
- Disconnect A/C lines from A/C condenser, if so equipped.
- 10. Remove A/C condenser, if so equipped.
- 11. Disconnect transmission oil cooler lines at transmission oil cooler and radiator.
- 12. Remove transmission oil cooler and brackets.
- 13. Disconnect radiator hoses at engine.
- Remove radiator shroud. Refer to Section 03-03, Engine Cooling.
- Remove radiator cooling fan using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B, or equivalent.

### CAUTION: LH thread. Remove by turning nut clockwise.

- Support radiator. Install lifting hooks in lifting eyes on radiator.
- Remove radiator attaching bolts from bottom of radiator and lift radiator out of vehicle.
- Loosen and remove vacuum pump and drive belt. Disconnect vacuum hose from transmission shift modulator tube.
- Loosen and remove alternator adjusting arm, adjusting arm bracket and drive belt. Pivot alternator inward toward engine.
- Disconnect alternator wiring harness from alternator.
- 21. Disconnect water temperature sender wire from sender on left front of engine block.
- Disconnect water temperature overheat lamp switch wire from switch on top front of left cylinder head.
- 23. Position wires out of the way.
- 24. Remove two engine ground cables from bottom front of engine.
- Remove power steering pump and bracket from engine.

- Disconnect and plug power steering pump return line.
- Position power steering pump out of the way.
   NOTE: Refrigerant system must be discharged prior to line removal. Refer to Group 36 for applicable procedures.
- 28. Remove A/C lines at A/C compressor.
- Remove vacuum hose between vacuum regulator valve (VRV) and injection pump and position out of the way.
- Disconnect and cap fuel heater inlet line at fuel filter and fuel pump.
- 31. Remove air cleaner assembly and inlet duct.
- Cover air intake opening with Intake Manifold Cover T83T-9424-A or equivalent.
- Disconnect and cap fuel filter outlet line at fuel filter and injection pump. Cap injection pump and fuel filter fittings.
- 34. Remove fuel filter return hose.
- Remove fuel filter and bracket from engine as an assembly.
- Loosen A/C compressor and rotate toward engine.
- 37. Remove and plug fuel inlet hose at fuel pump.
- Remove accelerator and speed control cables from injection pump and bracket on intake and position out of the way. Remove cable bracket.
- 39. Disconnect engine wiring harnesses from inside vehicle and position out of the way.
- 40. Remove transmission kickdown rod.
- 41. Disconnect heater hose from water pump and right cylinder head.
- Remove auxiliary heater and A/C hoses from bracket at left rear of engine, if so equipped.
- Disconnect oil pressure sender wire from sender on rear of engine.
- 44. Disconnect fuel return line from left rear of engine.
- 45. Remove transmission oil dipstick tube attaching bolt from rear of right cylinder head.
- Remove engine oil dipstick tube attaching nut from right exhaust manifold. Remove screw from valve cover bracket and remove dipstick and dipstick tube.
- 47. Remove the bolt attaching ground cable to cylinder block.
- 48. Remove top four transmission-to-engine attaching bolts.
- 49. Raise vehicle.
- 50. Remove the engine mount attaching nuts.
- 51. Disconnect the muffler inlet pipe at the exhaust manifolds.

- 52. Remove the converter inspection plate.
- Remove the four converter-to-flywheel attaching nuts.
- 54. Remove the starter cable.
- Position fuel line on No. 1 crossmember down and out of the way.
- 56. Lower the vehicle.
- Install Rotunda Engine Lifting Bracket 014-00312 or equivalent.
- 58. Support transmission and remove the remaining transmission-to-engine attaching bolts.
- 59. Separate engine from transmission, raise engine high-enough to clear number one crossmember, then pull engine forward and out of vehicle.

#### Installation

NOTE: If the engine to be installed has been overhauled or has been in storage, take the following precaution to prevent piston and bearing scuffing. Prime the entire engine lubricating system to fill the oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.

- 1. Lower engine into engine compartment.
- 2. Align torque converter with flywheel studs.
- Position transmission and install two lower transmission-to-engine attaching bolts. Tighten transmission-to-engine attaching bolts to specification.
- 4. Remove engine lifting bracket.
- 5. Raise the vehicle.
- 6. Install the starter cable and tighten to specification.
- Install the four converter-to-flywheel attaching nuts and tighten to specification.
- 8. Install the converter inspection plate and tighten to specification.
- 9. Connect the muffler inlet pipe to the exhaust manifolds and tighten to specification.
- 10. Install the engine mount attaching nuts and tighten to specification.
- 11. Position fuel line on No. 1 crossmember.
- 12. Lower vehicle.
- 13. Install the top four transmission-to-engine attaching bolts and tighten to specification.
- 14. Position engine oil dipstick to right exhaust manifold and valve cover bracket. Install dipstick attaching fasteners and tighten to specification. Install dipstick into dipstick tube.
- Position transmission oil dipstick tube to rear of right cylinder head and install attaching bolt. Tighten to specification. Install dipstick into dipstick tube.

- Connect fuel return line at left rear of engine and tighten to specification.
- 17. Connect battery ground cable to engine block.
- Connect auxiliary heater and A/C hoses to bracket at left rear of engine, if so equipped.
- Install heater hoses on right cylinder head and water pump and tighten clamps to specifications.
- 20. Install transmission kickdown rod.
- Connect engine wiring harness to inside of passenger compartment.
- Connect oil pressure sender wire to sender at rear of engine.
- Install accelerator cable bracket to intake manifold. Install accelerator and speed control cables to bracket and the injection pump.
- Remove plug from fuel inlet hose at fuel pump and install hose to fuel pump. Tighten clamp to specification.
- 25. Install fuel filter and bracket to engine.
- Remove caps from fuel filter, outlet line and injection pump. Install line between fuel filter outlet and injection pump.
- 27. Connect fuel filter return hose.
- Remove intake manifold cover and install air cleaner and inlet duct assembly.
- Connect fuel line between fuel filter inlet and fuel pump.
- Install vacuum hose between vacuum regulator valve (VRV) and injection pump.
- 31. Connect water temperature sender wire to sender on left front of engine block.
- 32. Connect wire to water temperature overheat lamp switch on top of left cylinder head.
- Install A/C lines and A/C drive belt to the A/C compressor. Refer to Section 12-03B, A/C-Heater System—E-150-E-350, in the Body/Chassis/Electrical Shop Manual.
- 34. Remove plug from power steering pump return line and install return line hose.
- Install power steering pump drive belt and bracket.
- 36. Install two engine ground cables to bottom front of engine.
- Connect alternator wiring harness to alternator and fuel line heater.
- Loosely attach alternator adjusting arm and adjusting bracket to alternator and engine. Install drive belt.
- 39. Loosely install vacuum pump to engine. Install vacuum pump drive belt and connect vacuum hose transmission shift modulator tube.

- Adjust all accessory drive belt to specifications. Refer to Section 03-05, Belt Accessory Drive Service.
- 41. Position radiator into engine compartment and install radiator attaching bolts.
- 42. Install radiator cooling fan.

  CAUTION: LH thread. Tighten nut by turning counterclockwise.
- 43. Install radiator shroud. Refer to Section 27-04, Radiators, in this Manual.
- 44. Connect radiator hoses to engine.
- Install transmission oil cooler and brackets and tighten to specifications.
- 46. Connect transmission oil cooler lines to transmission oil cooler and radiator.
- Install A/C condenser, if so equipped. Refer to Section 12-03B, A/C-Heater System—E-150-E-350, in the Body/Chassis/Electrical Shop Manual.
- Connect A/C lines to A/C condenser, if so equipped.
- 49. Charge the A/C system. Refer to Section 12-03B, A/C-Heater System—E-150-E-350, in the Body/Chassis/Electrical Shop Manual.
- 50. Install upper grill support.
- Install hood latch and cable assembly to grille upper support bracket.
- Install speed control servo bracket, if so equipped.
- Install front bumper, grille assembly and gravel deflector.
- 54. Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling.
- 55. Connect ground cables to both batteries.
- Check the engine oil level and fill as needed with the specified type and grade of oil.
- Run engine and check for fuel, oil and coolant leaks.
- 58. Install engine cover.

#### **Engine Front Insulators**

F-250 — F-350 F-Super Duty Chassis Cab and Stripped Chassis

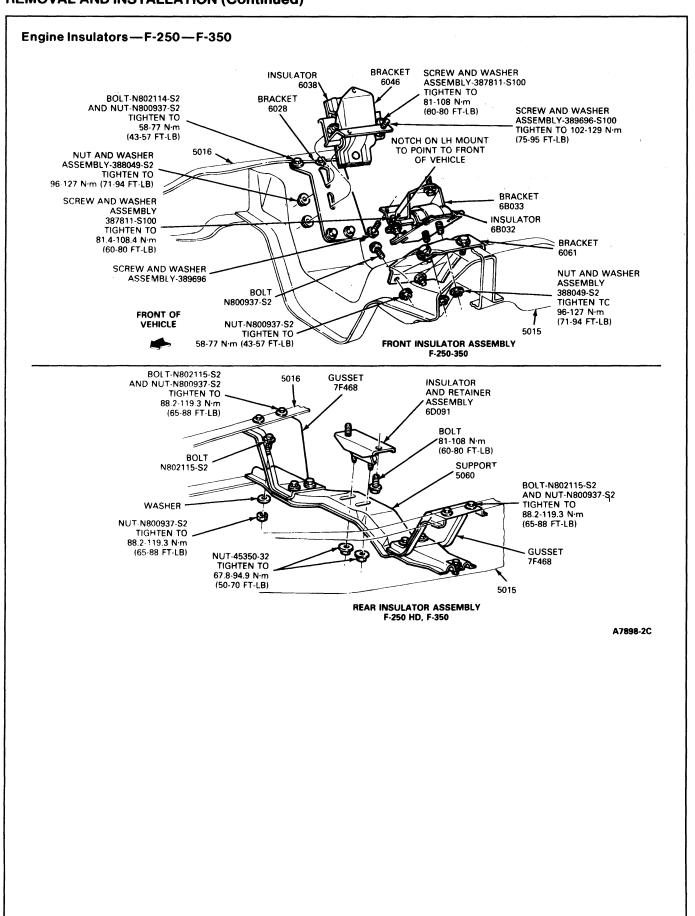
#### Removal

- 1. Disconnect ground cables from both batteries.
- Remove fan shroud halves. Refer to Section 03-03, Engine Cooling.
- Raise vehicle.

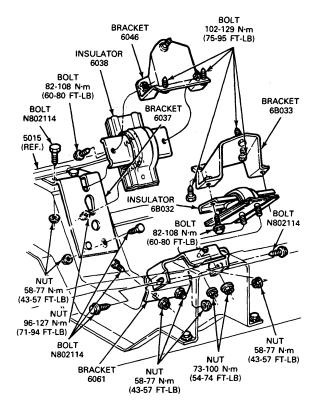
- 4. Remove nuts attaching insulators to crossmember.
- Disconnect muffler inlet pipes at exhaust manifolds.
- Remove bolts attaching insulators to engine block.
- 7. Lower vehicle.
- Install Rotunda Universal Load Positioning Sling 014-00036 or equivalent, to lifting eyes on engine and raise engine high enough for insulators to clear crossmember.
- 9. Remove insulator and bracket assemblies.
- 10. Remove insulator from bracket.

#### Installation

- Install insulator onto insulator bracket and tighten to specifications.
- Install insulator and bracket assembly onto engine block and tighten to specifications.
- 3. Lower engine onto crossmember.
- 4. Remove lifting sling.
- 5. Raise vehicle.
- 6. Install insulator-to-crossmember attaching nuts and washers and tighten to specifications.
- 7. Lower vehicle.
- 8. Install radiator fan shroud. Refer to Section 27-04, Radiators.
- 9. Connect ground cables to both batteries.



### Engine Insulators — F-Super Duty Commercial Stripped Chassis Vehicles



INSTALLATION - ENGINE MOUNTS FRONT

A11949-1A

#### Removal

#### E-250 -- E-350

- Disconnect battery ground cables from both batteries.
- 2. Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- Loosen vacuum pump and remove vacuum pump drive belt.
- Loosen alternator and remove alternator drive belt.
- Disconnect alternator wiring harness from alternator.
- 6. Remove alternator adjusting bracket.
- Remove alternator through bolt and remove alternator from engine.
- 8. Remove fuel filter / fuel heater / water separator inlet line from fuel pump and fuel filter.
- Discharge the A/C system, if so equipped. Refer to Section 12-03B, A/C-Heater System—E-150—E-350, in the Body/Chassis/Electrical Shop Manual.

- Remove A/C hoses, if so equipped (refer to Section 12-03B, A/C-Heater System—E-150—E-350.
- Remove A/C compressor and bracket, if so equipped. Refer to Section 12-03B, A/C-Heater System—E-150—E-350.
- 12. Remove engine cover.
- Remove air cleaner and install Intake Manifold Cover T83T-9424-A, or equivalent, over air intake opening.
- Remove and cap fuel filter / fuel heater / water separator to injection pump fuel line. Cap injection pump and fuel filter fittings.
- Remove fuel filter / fuel heater / water separator return line hose.
- Remove fuel filter/fuel heater/water separator bracket attaching bolts and remove filter and bracket as an assembly.
- 17. Remove kickdown rod from injection pump.
- 18. Raise vehicle.
- Disconnect ground cables from lower front of engine.
- Remove nuts attaching insulators to No. 1 crossmember.
- Disconnect and remove transmission kickdown rod from transmission.
- 22. Lower vehicle.
  - NOTE: If engine has no lifting eye on RH rear side, move LH rear lifting eye to RH side. Use a 3-inch bolt to attach eye to RH side.
- 23. Install Rotunda Engine Lifting Brackets 014-00312 or equivalent, to front of engine. Attach turn buckle to RH rear lifting eye.
- 24. Raise engine until it contacts body.
- 25. Remove insulator and bracket assemblies.

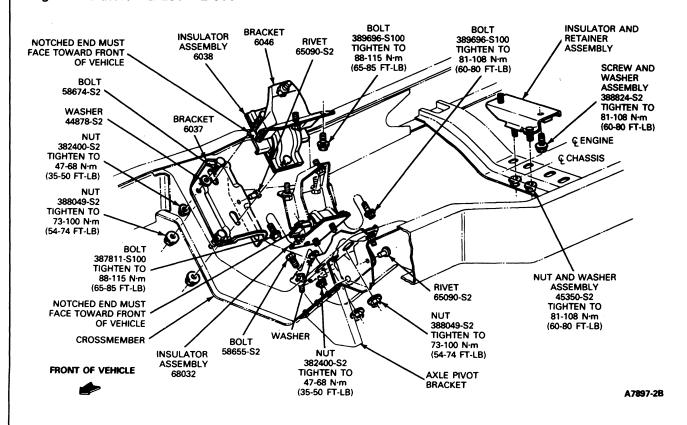
#### Installation

- Install insulator to bracket and tighten to specifications.
- 2. Install insulator and bracket assembly onto engine and tighten to specifications.
- Lower engine.
- 4. Remove turnbuckle from RH rear lifting eye and remove lifting bracket from front of engine.
- Transfer lifting eye from RH side to LH side if removed. Install original manifold bolts and tighten to specification.
- 6. Raise vehicle.
- Install insulator to crossmember No. 1 with attaching nuts and tighten to specifications.
- Install transmission kickdown rod and connect to transmission.

- Install engine ground cables and tighten to specification.
- 10. Lower vehicle.
- Install fuel filter/fuel heater/water separator and bracket assembly and tighten to specification.
- Uncap and install fuel filter / fuel heater / water separator to injection pump fuel line.
- Install fuel filter/fuel heater/water separator return hose and clamp.
- Remove intake opening cover. Install air cleaner and tighten to specifications.
- Install A/C compressor and bracket, if so equipped, and tighten to specifications. Refer to Section 12-03B, A/C-Heater System—E-150—E-350), in the Body/Chassis/Electrical Shop Manual.
- Install A/C hoses (refer to Section 12-03B, A/C-Heater System—E-150—E-350), if so equipped.
- 17. Install A/C compressor drive belt, if so equipped.

- 18. Install fuel pump to fuel filter/fuel heater/water separator line and tighten to specification.
- 19. Install alternator and alternator adjusting bracket.
- 20. Install alternator drive belt.
- 21. Install alternator wiring onto alternator.
- Install vacuum pump drive belt on alternator pulley.
- Adjust A/C compressor, alternator, and vacuum pump drive belts to specification. Refer to Section 03-05, Belt Accessory Drive Service.
- Install fan and clutch assembly and tighten to specifications. Refer to Section 03-03, Engine Cooling.
- Install fan shroud. Refer to Section 03-03, Engine Cooling.
- Evacuate and charge A/C system, if so equipped. Refer to Section 12-03B, A/C-Heater System—E-150—E-350, in the Body/Chassis/Electrical Manual.
- 27. Connect battery ground cables to both batteries.
- 28. Install engine cover.

#### Engine Insulators — E-250 — E-350



#### **Engine Rear Insulator**

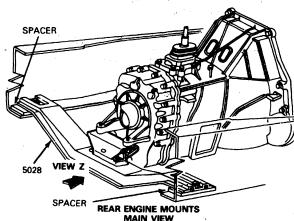
#### Removal

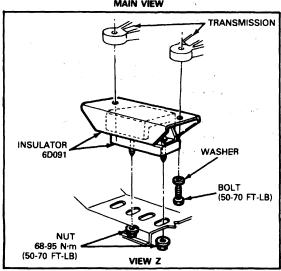
- Remove the insulator-to-support assembly bolt and locknut.
- Remove the insulator-to-transmission housing bolts and lockwashers.
- Raise the transmission with a floor jack and remove the insulator and retainer.

#### Installation

- Position the insulator and retainer to the transmission housing and install the attaching bolts and lockwashers, using the holes noted on removal. Tighten to specifications.
- 2. Lower the transmission and remove the jack.
- 3. Install the insulator-to-support assembly bolt and locknut. Tighten to specification.
- 4. Lower the vehicle.

### Engine Insulators—F-Series Stripped Chassis with 7.3L Diesel





A11950-1C

#### **Water Pump**

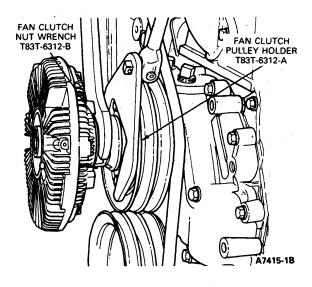
#### Removal

- Disconnect battery ground cables from both batteries.
- Drain cooling system. Refer to Section 03-03, Engine Cooling.
- Remove radiator fan shroud halves. Refer to Section 03-03, Engine Cooling.
- Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B, or equivalent.

### CAUTION: LH thread: Remove by turning nut clockwise.

- Loosen power steering pump and A/C compressor. Remove drive belts.
- 6. Loosen vacuum pump and remove drive belt.
- 7. Loosen alternator and remove drive belt.
- 8. Remove water pump pulley.
- 9. Disconnect heater hose from water pump.
- 10. Remove heater hose fitting from water pump.
- Remove alternator adjusting arm and adjusting arm bracket.
- Remove A/C compressor and position out of the way.
- 13. Remove A/C compressor brackets.
- Remove power steering pump and bracket and position out of the way.
- 15. Remove bolts attaching water pump to front cover and remove pump.

#### **Removing Fan and Clutch Assembly**

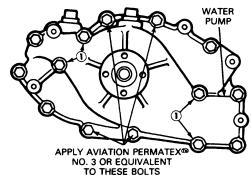


#### Installation

 Clean water pump and engine front cover mating surfaces with suitable solvent. Clean bolt threads.

NOTE: Coat two top bolts and two bottom bolts with Aviation Permatex TM No. 3 or equivalent before installation. Install bolts within five minutes of sealer application. Ensure that correct length bolts are installed in correct holes.

#### **Water Pump**



TO THESE BOLTS

1) THESE BOLTS 2 3/4-INCHES LONG.
ALL OTHERS ARE 1 1/2 INCHES LONG.

A7353-1E

- Install water pump with new gasket and tighten to specifications.
- Install alternator adjusting arm bracket and tighten to specifications.
- 4. Install water pump pulley and tighten to specification.
- Coat heater hose fitting with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent, and install in water pump. Tighten to specifications.
- Connect heater hose to water pump and tighten clamp to specifications.
- 7. Install power steering pump bracket and tighten to specification.
- 8. Install power steering pump and drive belt.
- Install A/C compressor bracket and tighten to specification.
- 10. Install A/C compressor and drive belt.
- Install alternator adjusting arm and alternator drive belt.
- 12. Install vacuum pump drive belt.

- Adjust accessory drive belts to specification. Refer to Section 03-05, Belt Accessory Drive Service.
- Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent, and tighten to specification.

### CAUTION: LH thread. Turn nut counterclockwise to tighten.

- Install radiator fan shroud halves. Refer to Section 03-03, Engine Cooling.
- 16. Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling.
- 17. Connect ground cables to both batteries.
- 18. Run engine and check for coolant leaks.

### Crankshaft Vibration Damper

#### Removal

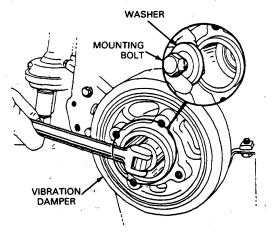
- 1. Disconnect ground cables from both batteries.
- 2. Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- Remove fan and clutch assembly as outlined using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

### CAUTION: LH thread. Remove by turning nut clockwise.

- 4. Loosen and remove A/C compressor drive belt.
- Loosen and remove power steering pump drive belt.
- Loosen and remove alternator and vacuum pump drive belts.
- 7. Raise vehicle.
- 8. Remove crankshaft pulley.
- 9. Remove bolt attaching damper to crankshaft.
- Install Crank / Cam Gear and Damper Remover T83T-6316-A or equivalent, and remove crankshaft damper.

NOTE: To prevent crankshaft rotation, use breaker bar for in vehicle removal, or Flywheel Holding Tool T74P-6375-A or equivalent, for bench overhaul.

#### **Crankshaft Damper Removal**



A10727-1A

#### Installation

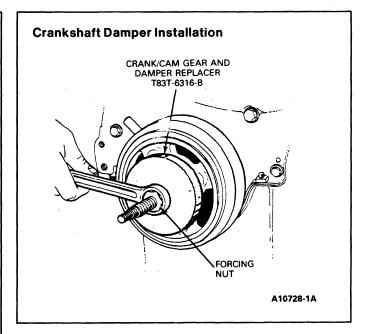
NOTE: A new front crankshaft seal should be installed whenever the crankshaft damper is removed.

- Lubricate the damper seal nose with clean engine oil, and install using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent.
  - NOTE: Add Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent to engine side of washer (in area of keyway only), to prevent oil leakage past keyway.
- Install bolt attaching damper to crankshaft and tighten to specification.
- 3. Install crankshaft pulley and tighten to specification.
- 4. Lower vehicle.
- Install alternator, vacuum pump, power steering pump, and A/C compressor drive belts. Adjust to specification. Refer to Section 27-06, Accessory Drive Belt Service.
- Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

### CAUTION: LH thread. Turn nut counterclockwise to tighten.

Tighten nut to specifications.

- 7. Install radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- 8. Connect ground cables to both batteries.



# Front Crankshaft Oil Seal In-Vehicle Replacement Use The Following Procedure Removal

- Disconnect battery ground cables from both batteries.
- 2. Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- Remove fan and clutch assembly as outlined using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

CAUTION: LH thread. Remove by turning nut clockwise.

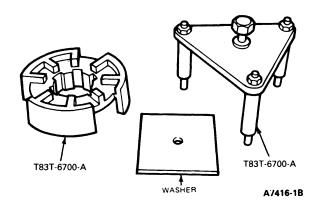
- 4. Loosen and remove A/C compressor drive belt.
- Loosen and remove power steering pump drive belt.
- Loosen and remove alternator and vacuum pump drive belts.
- 7. Raise vehicle.
- 8. Remove crankshaft pulley.
- 9. Remove bolt attaching damper to crankshaft.
- Install Crank / Cam Gear and Damper Remover T83T-6316-A, or equivalent, and remove crankshaft vibration damper. To prevent crankshaft rotation install breaker bar into removal tool.
- Pry out front oil seal from the front cover using a screwdriver.

CAUTION: Use care to prevent damage to the front cover, crankshaft or breaking oil pan seal by bending front cover.

#### Installation

 Coat new oil seal with Multi-Purpose grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent.
 NOTE: It may be necessary to rotate crankshaft to align the damper key with seal installing tool.

### Front Crank Seal Replacer-T83T-6316-A — In Vehicle



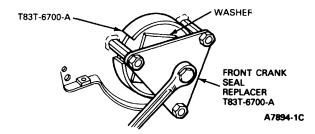
 For engines without three weldnuts on front cover, place seal into Front Crank Seal Replacer T83T-6700-A or equivalent, and install over end of crankshaft. Install Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent, and tighten nut against washer and installation tool to force seal into front cover plate.

# CAUTION: Use care to prevent bending front cover during oil seal installation and breaking oil pan seal.

 For engines with three weldnuts on front cover, place seal into Front Crank Seal Replacer T83T-6700-A or equivalent, install over end of crankshaft and attach bridge to weldnuts. Draw seal into front cover by rotating center screw clockwise.

NOTE: Seal is automatically installed at the proper depth when the tool bottoms on the front cover.

#### Front Crankshaft Seal Installation — In Vehicle



 Clean grease from outside surfaces and apply a 3.2mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent, around the outside diameter of the front seal and the edge of the front cover. NOTE: When applying RTV rubber silicone sealant, always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.

- Lubricate the damper seal nose with clean engine oil and install crankshaft vibration damper using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent.
- Add Silicone Rubber Sealant D6AZ-19562-A or equivalent, to engine side of washer (in area of keyway only), to prevent oil leakage past keyway. Install bolt attaching vibration damper to crankshaft and tighten to specification.
- Install crankshaft pulley and tighten to specification.
- Lower vehicle.
- Install alternator, vacuum pump, power steering pump, and A/C compressor drive belts. Adjust to specification. Refer to Section 03-05, Belt Accessory Drive Service.
- Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

CAUTION: LH thread. Turn nut counterclockwise to tighten. Tighten nut to specifications.

- Install radiator fan shroud halves. Refer to Section 03-03, Engine Cooling.
- 12. Connect ground cables to both batteries.

### **Engine Front Cover and Crankshaft Oil Seal Bench Procedure-Use The Following Procedure**

#### Removal

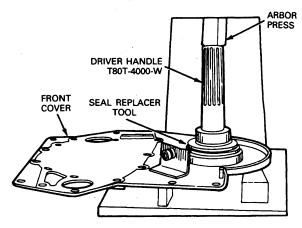
- 1. Disconnect ground cables from both batteries.
- 2. Drain cooling system.
- Remove air cleaner and install intake air opening cap Intake Manifold Cover T83T-9424-A or equivalent.
- Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

CAUTION: LH thread. Remove by turning nut clockwise.

- 6. Remove injection pump, as outlined.
- 7. Remove injection pump adapter, as outlined.
- 8. Remove water pump, as outlined.
- 9. Raise vehicle.

- Remove crankshaft pulley and vibration damper, as outlined.
- 11. Remove ground cables at front of engine.
- Remove five bolts attaching front cover to engine block and oil pan.
- 13. Lower vehicle.
- 14. Remove bolts attaching engine front cover to engine block, and remove front cover.
- Support engine front cover, and using an arbor press, Drive Handle T80T-4000-W or equivalent, and an 82.55mm (3 1/4 inch) diameter spacer, drive crankshaft seal out of front cover.

#### **Engine Front Cover Oil Seal Removal**



A7357-1B

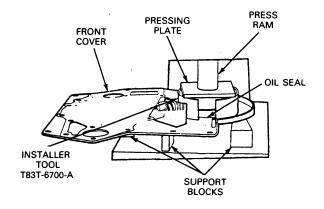
#### Installation

- Remove old gasket material and clean engine block, engine front cover, and oil pan sealing surfaces with a suitable solvent and dry thoroughly.
- 2. Clean water pump sealing surface.
- Coat new front crankshaft oil seal with Multi-Purpose grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent.
- Install new oil seal using Front Crank Seal Replacer T83T-6700-A or equivalent, a suitable spacer, and an arbor press.

#### **CAUTION: Support engine front cover.**

Bottom out tool on front cover surface. Seal is automatically installed at proper depth.

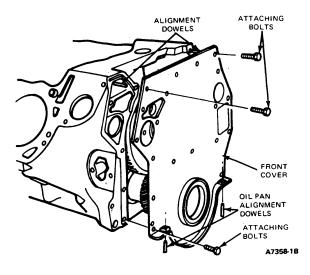
#### **Engine Front Cover Oil Seal Installation**



A10729-1A

- Clean outside surfaces of the front cover to remove any grease and apply a 3.2mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent, around the outside diameter of the front seal and the edge of the front cover.
- For in-vehicle repair, install fabricated alignment dowels, on engine block and oil pan to align front cover and gaskets. For overhaul repair, install fabricated alignment dowels as shown.

#### **Front Cover Alignment Dowels**

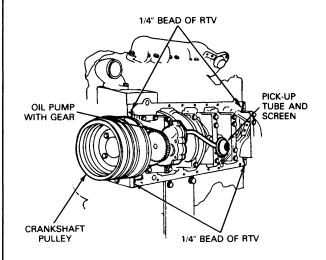


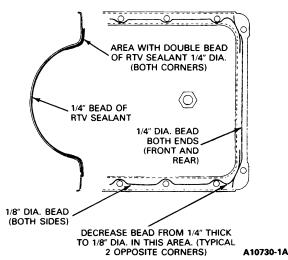
- Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent on engine block and front cover sealing surfaces.
- 8. Install gaskets on engine block.

NOTE: Silicone Rubber Sealant should be applied immediately prior to front cover installation. When applying Silicone Rubber Sealant, always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to "set-up" and sealing effectiveness may be reduced.

For in vehicle repair, apply a 3.2mm (1/8-inch) bead of Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent, to rear corners of oil pan and apply a 6.4mm (1/4-inch) bead of Silicone Rubber D6AZ-19562-A, or equivalent on oil pan as shown.

#### **Front Cover RTV Sealant**

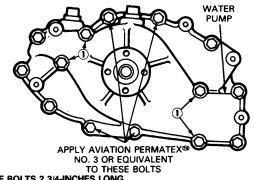




 Install engine front cover in position, on oil pan dowels first, and install three attaching bolts as shown previously.

- For in-vehicle repair, remove engine front cover alignment dowels from engine and oil pan. Install and hand tighten remaining front cover bolts.
- Install fabricated alignment dowels in engine block, if necessary.
- Install water pump gasket on engine front cover alignment dowels.
- Install water pump and hand tighten bolts.
   NOTE: Apply Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent to four bolts as shown.

#### **Water Pump**



THESE BOLTS 2 3/4-INCHES LONG. ALL OTHERS ARE 1 1/2 INCHES LONG.

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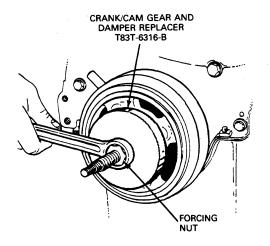
 Remove alignment dowels and install two remaining attaching bolts.

Tighten all water pump bolts to specification.

- 16. Tighten engine front cover bolts to specification.
- 17. Install injection pump adapter, as outlined.
- 18. Install injection pump, as outlined.
- 19. Install heater hose fitting in pump using Pipe Sealant With Teflon® D8AZ-19554-A, (ESG-M4G194-A) or equivalent.
- 20. Connect heater hose to water pump and tighten clamp to specification.
- 21. Raise vehicle.
- Lubricate damper seal nose with clean engine oil and install crankshaft vibration damper, using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent.

NOTE: Add Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A), to engine side of retaining bolt washer to prevent oil leakage past keyway.

#### **Crankshaft Damper Installation**



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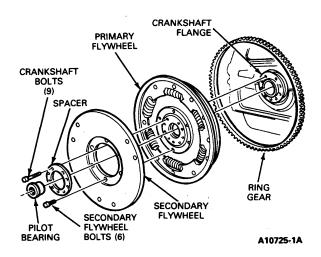
- 23. Install vibration damper-to-crankshaft attaching bolt and tighten to specification.
- Install crankshaft pulley and tighten to specification.
- 25. Install both battery ground cables on front of engine.
- 26. Lower vehicle.
- 27. Install alternator adjusting arm bracket and tighten to specification.
- Install water pump pulley and tighten to specification.
- 29. Install power steering pump bracket and tighten to specification.
- 30. Install power steering pump and drive belt.
- 31. Install A/C compressor bracket and tighten to specification.
- 32. Install A/C compressor and drive belt.
- Install alternator adjusting arm and install alternator and vacuum pump drive belts.
- 34. Adjust alternator, vacuum pump, power steering pump and A/C compressor drive belts to specification. Refer to Section 03-05, Belt Accessory Drive Service.
- 35. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents.
- 36. Install radiator fan shroud halves. Refer to Section 03-03, Engine Cooling.
- Remove intake manifold cover. Install air cleaner and tighten to specification.
- 38. Connect ground cables to both batteries.
- Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling.

40. Operate engine and inspect for coolant and oil leaks.

### Flywheel, Engine Rear Cover and Oil Seal Removal

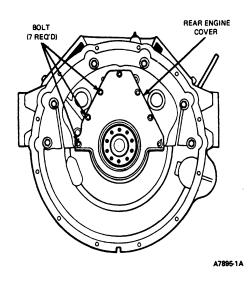
- Remove transmission and integral clutch housing (manual transmission). Refer to Group 07 or Group 08, in Body / Chassis / Electrical Manual.
- Remove clutch and clutch housing, if so equipped. Refer to Group 08, in Body/Chassis/Electrical Manual.
- Remove nine flywheel mounting bolts and spacer and remove flywheel.

#### **Dual Mass Flywheel**



 Remove bolts attaching rear engine cover to engine block and remove rear cover.

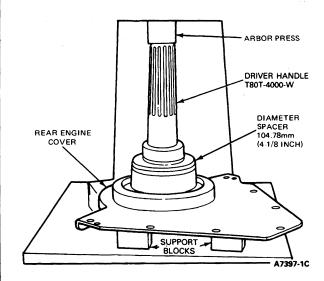
#### **Rear Engine Cover Removal**



 Using an arbor press and a suitable spacer 104.78mm (4 1/8-inch) diameter, remove rear oil seal.

NOTE: Support rear cover.

#### Rear Oil Seal Removal and Installation



NOTE: If rear cover seal fails repeatedly, check rear cover bore concentricity as follows:

- Install rear cover to engine with oil seal removed.
- Mount a dial indicator (on swivel joint) onto the crankshaft flange. Position the dial indicator press against the I.D. of the rear cover seal bore.
- Measure at four equal spaced locations.
- Rear cover seal bore will be connected to the crankshaft centerline in accordance with Specifications.
- Replace rear cover if not within specifications.

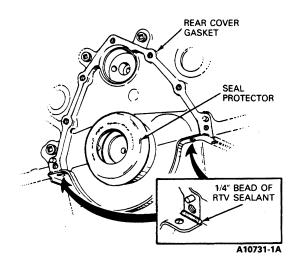
#### Installation

- Clean rear cover and engine block gasket surfaces.
- Remove old RTV sealant from oil pan to rear cover sealing surface on oil pan. Clean sealing surfaces with a suitable solvent, and dry thoroughly.
- Coat rear engine cover seal bore I.D. with Gasket and Trim Adhesive, D7AZ-19B508-AA (ESR-M11P17-A) or equivalent. Using an arbor press and Rear Crankshaft Seal Replacer T83T-6701-A or equivalent, install new rear main oil seal.

NOTE: Seal must be installed from the engine block side of rear cover flush with seal bore inner surface.

- Apply a 3.2mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA (ESB-M4G92-A) or equivalent around the outside diameter of the rear seal and the edge of the rear cover.
- Install Rear Crankshaft Seal Pilot T83T-6701-B or equivalent, onto crankshaft.
- Apply Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A), or equivalent, to engine block and rear cover gasket surfaces.
- 7. Install rear cover gasket to engine block.

#### **Rear Cover Gasket Installation**



For in-vehicle repair, apply a 6.35mm (1/4 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA (ESB-M4G92-A) or equivalent at the corners or the oil pan and apply a 6.35mm (1/4 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA (ESB-M4G92-A) or equivalent, on oil pan sealing surface.

NOTE: When applying Silicone Rubber Sealant, D6AZ-19562-AA (ESB-M4G92-A) or equivalent, always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to "set-up", and sealing effectiveness may be reduced.

- Push rear cover into position on engine block and install attaching bolts. Remove Seal Pilot, T83T-6701-B. Tighten all bolts to specification.
- Position flywheel on crankshaft flange. Coat threads of flywheel attaching bolts with Perfect Seal Sealing Compound B5A-19554-A (ESE-M4G115-A), or equivalent, and install spacer, bolts and washers (with flexplate, if so equipped). Tighten bolts to specification, alternating across from each other.
- Install clutch, if so equipped. Refer to Group 08, in Body/Chassis/Electrical Manual.

- Install transmission. Refer to Group 07 or Group 08 in Body / Chassis / Electrical Manual.
- 13. Run engine and check for oil leaks.

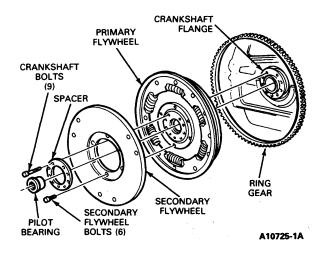
#### Secondary Flywheel

#### Removal

NOTE: The secondary flywheel inertia mass contains the clutch friction surface. Excessive clutch slipping can result in warpage or other surface distress which requires refacing or replacement of the secondary flywheel. Refer to Inspection and Repair in this section. The back side of the secondary flywheel contains a friction surface which is used in the internal torque limitation system of the Dual Mass Flywheel assembly.

- Remove the transmission, clutch pressure plate, and disc as outlined in Group 08 of the Body/Chassis/Electrical Manual.
- Remove six bolts retaining the secondary flywheel to the primary flywheel assembly. Do not permit the flywheel to fall from the vehicle.
- Using a screwdriver or other suitable tool, pry the secondary flywheel off of its mounting pilot. Use care when removing the flywheel to prevent dropping.

#### **Dual Mass Flywheel**



#### Installation

- Clean the clutch friction surface and torque limitation friction surface with a suitable commercial alcohol base solvent to be sure that surfaces are free from any oil film.
- Position secondary flywheel onto its mounting pilot on the primary flywheel assembly and align the six secondary flywheel attaching bolt holes with the six threaded holes of the primary flywheel assembly.

- Coat threads of secondary flywheel attaching bolts with Ford Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A) or equivalent, and install bolts. Tighten bolts to specification, alternating across from each other.
- Install the clutch pressure plate, disc, and transmission as outlined in Group 08 of the Body/Chassis/Electrical Manual.

#### Flywheel Ring Gear

#### Removal

- Remove transmission. Refer to Group 07 in the Body/Chassis/Electrical Manual.
- Remove the clutch housing. Refer to Group 08 in the Body / Chassis / Electrical Manual.
- 3. Remove flywheel as outlined.
- To replace a damaged or worn ring gear, heat the ring gear with a blow torch on the engine side of the gear, and knock it off the flywheel. Do not hit the flywheel when removing the ring gear.

#### Installation

- Heat the new ring gear evenly until the gear expands enough to slip onto the flywheel. Make sure the gear is seated properly against the shoulder. Do not heat any portion of the gear to a temperature higher than 278°C (500°F). If this limit is exceeded, the hardness will be removed from the ring gear teeth.
- 2. Install flywheel as outlined.
- Install clutch housing and transmission. Refer to Group 08 in the Body / Chassis / Electrical Manual.

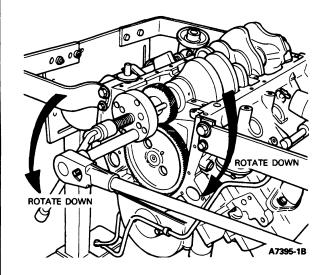
#### **Crankshaft Drive Gear**

#### Removal

- 1. Disconnect ground cables from both batteries.
- Remove air filter and install Intake Manifold Cover T83T-9424-A or equivalent, on intake manifold opening.
- 3. Drain cooling system.
- 4. Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling, in this Manual.
- Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.
   NOTE: LH thread. Turn nut clockwise to remove.
- 6. Loosen and remove alternator and vacuum pump
- Remove A / C compressor and position out of the way.

- Remove A/C mounting bracket.
- Remove power steering pump and position out of the way.
- 10. Remove power steering pump bracket.
- 11. Remove water pump pulley.
- 12. Remove water pump, as outlined.
- Remove engine front cover, as outlined.
- Install Crank / Cam Gear and Damper Remover T83T-6316-A or equivalent, and using a breaker bar (in-vehicle procedure) to prevent crankshaft rotation, or Flywheel Holding T74P-6375-A (bench procedure) or equivalent, remove crankshaft gear.

#### **Crankshaft Drive Gear Removal**

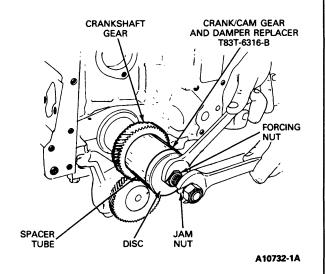


#### Installation

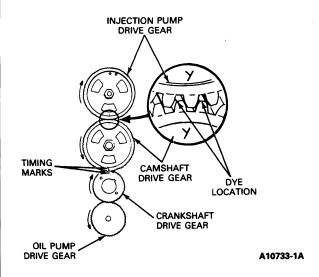
 Install crankshaft gear using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent, aligning crankshaft drive gear timing mark with crankshaft drive gear timing mark.

NOTE: Gear may be heated to 149-177°C (300-350°F) for ease of installation. Heat in oven. Do not use torch.

#### **Crankshaft Drive Gear Installation**



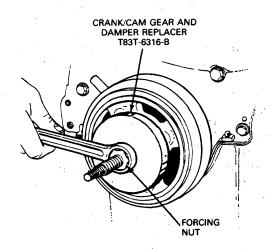
#### **Aligning Timing Marks**



- Clean engine front cover, water pump and engine block sealing surface with a suitable solvent and dry thoroughly.
- Install new crankshaft oil seal into engine front cover, as outlined.
- 4. Install engine front cover, as outlined.
- Install crankshaft vibration damper using Crank/Cam Gear and Damper Replacer T83T-6316-B or equivalent.

NOTE: Apply Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent, to engine side of washer (in area of keyway only), to prevent oil leakage past Keyway.

#### **Crankshaft Damper Installation**



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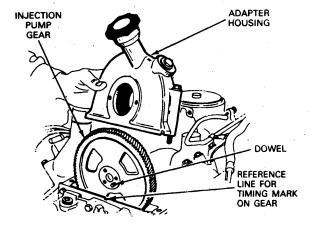
- 6. Install crankshaft vibration damper attaching bolt and tighten to specification.
- 7. Install crankshaft pulley and tighten to specification.
- 8. Install water pump as outlined.
- 9. Install injection pump adapter as outlined.
- 10. Install injection pump as outlined.
- Install heater hose fitting into water pump using Pipe Sealant With Teflon® D8AZ-19554-A (ESG-M4G194-A), or equivalent.
- 12. Connect heater hose to water pump and tighten clamp to specification.
- 13. Install power steering pump bracket and tighten to specification.
- 14. Install power steering pump and drive belt.
- Install A/C compressor bracket and tighten to specification.
- 16. Install A/C compressor and drive belt.
- 17. Install alternator adjusting arm. Install alternator, vacuum pump and drive belts.
- Adjust alternator, vacuum pump, power steering pump, and A/C compressor drive belts to specification. Refer to Section 03-05, Accessory Drive Belt Service.
- 19. Refer to Engine / Emissions Diagnosis Manual\* for injection pump timing procedure.
- Install radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents. Tighten to specification.
- 21. Install radiator fan shroud halves. Refer to Section 03-03, Engine Cooling.

- 22. Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling.
- 23. Remove intake manifold cover. Install aircleaner and tighten to specification.
- 24. Connect ground cables to both batteries.
- 25. Operate engine and inspect for oil and coolant leaks.

### Injection Pump Drive Gear and Gear Cover Removal

- 1. Disconnect ground cables from both batteries.
- 2. Remove engine cover (E-250—E-350 only).
- Remove air cleaner and install intake opening cover, Intake Manifold Cover T83T-9424-A or equivalent.
- Remove injection pump, as described in this section.
- Remove bolts attaching injection pump drive gear cover to engine block, and remove cover.
   NOTE: Do not remove drive gear yet.

#### **Drive Gear Cover**



A10734-1A

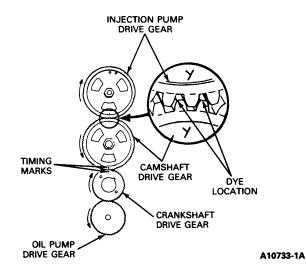
Turn engine over by hand to TDC (compression stroke) of No. 1 piston.

NOTE: Remove glow plugs with Glow Plug Socket D83T-6002-A or equivalent, to facilitate turning engine over by hand.

NOTE: To determine that No. 1 piston is at TDC (compression stroke), position injection pump drive gear dowel at four o'clock position. The scribe line in vibration damper should be at TDC.

NOTE: To aid aligning the timing marks, the pump drive gear and the camshaft gear are marked with "Y" timing marks. The crankshaft and camshaft gears are marked with "o" (dot) alignment marks. With engine at TDC Compression for No. 1 cylinder, the "Y" marks should be aligned.

#### **Aligning Timing Marks**



 Slide injection pump gear back (do not remove) to expose top of camshaft gear when looking down into the front cover. In addition to the "Y", the gear teeth adjacent to the "Y" on the camshaft gear are permanently dyed.

CAUTION: Do not remove injection pump gear without following the above procedure.

8. Remove injection pump drive gear.

#### Installation

 Clean all gasket and sealing surfaces with a suitable solvent and dry thoroughly.

NOTE: To determine that No. 1 piston is at TDC of compression stroke, position injection pump drive gear dowel at four o'clock position. The scribe line in vibration damper should be at TDC.

 With drawn line on drive gear at six o'clock position, install gear and align all drive gear timing marks.

CAUTION: Use extreme care to avoid disturbing injection pump drive gear, once it is in position.

 Apply a 3.16mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent, along bottom surface of injection pump drive gear cover. NOTE: When applying Silicone Rubber Sealant, D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent, always use the bead size specified and join the components within 15 minutes of application. After 15 minutes, sealant begins to "set-up", and sealing effectiveness may be reduced.

 Install injection pump drive gear cover and tighten retaining bolts to 19 N·m (14 ft-lb). Apply Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A), or equivalent, to bolt threads before assembly.

NOTE: With injection pump drive gear cover installed, the injection pump drive gear cannot "jump" timing.

- Remove intake manifold cover. Install air cleaner and tighten to specification.
- 6. Install ground cables to both batteries.
- 7. Run engine and check for oil, fuel and coolant leaks.
- If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

CAUTION: Keep eyes and hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

9. Install engine cover (E-250—E-350).

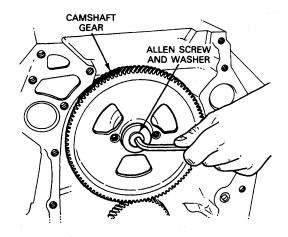
### Camshaft Drive Gear, Fuel Pump Cam, Spacer and Thrust Plate

#### Removai

- 1. Disconnect ground cables from both batteries.
- Remove air cleaner and install Intake Manifold Cover T83T-9424-A or equivalent, on intake manifold opening.
- Drain cooling system. Refer to Section 03-03, Engine Cooling.
- Loosen and remove alternator and vacuum pump drive belts.
- Remove A / C compressor mounting bolts and position compressor out of the way.
- 6. Remove A/C compressor mounting bracket.
- Remove power steering pump and position out of the way.
- 8. Remove power steering pump bracket.
- 9. Remove water pump pulley.
- 10. Remove water pump, as outlined.
- 11. Remove engine front cover, as outlined.

12. Remove camshaft allen screw and washer.

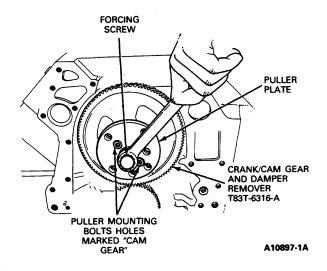
#### **Camshaft Drive Gear Allen Screw**



A10896-1A

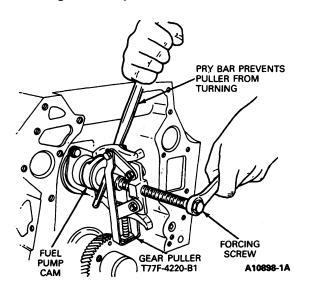
 Install gear puller, using Crank/Cam Gear and Damper Remover T83T-6316-A or equivalent and remove gear.

#### **Camshaft Drive Gear Removal**

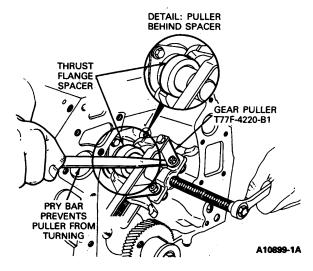


- If necessary, remove fuel supply pump as outlined.
- Install Gear Puller T77F-4220-B1 or equivalent, and remove fuel pump cam and thrust flange spacer, if necessary.

#### **Removing Fuel Pump Cam**



#### **Removing Thrust Flange Spacer**

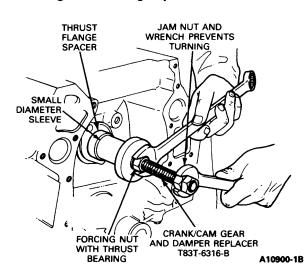


 Remove bolts attaching thrust plate, and remove thrust plate, if necessary.

#### Installation

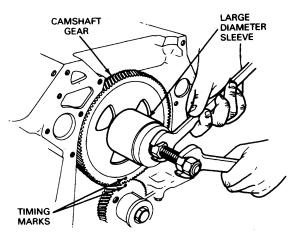
- Install new thrust plate, if removed, and tighten to specification.
  - NOTE: Replace fuel pump cam if nicked, scored, or otherwise damaged. If fuel pump cam is replaced, replace fuel pump.
- Install spacer and fuel pump cam against camshaft thrust flange, using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent, if removed.

#### **Installing Thrust Flange Spacer**



 Install camshaft drive gear against fuel pump cam, aligning timing mark with mark on crankshaft drive gear, using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent.

#### **Installing Camshaft Gear**



A11901-1A

- Install camshaft allen screw and tighten to specification.
- Install fuel pump as outlined.
- Install new crankshaft oil seal in engine front cover, as outlined.

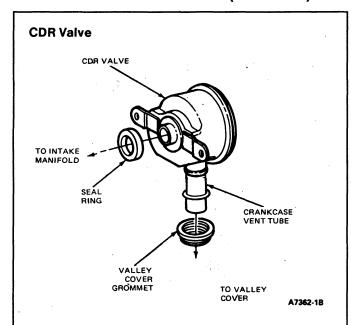
- 7. Install engine front cover, as outlined.
- 8. Install water pump, as outlined.
- Install injection pump gear and adapter, as outlined.
- 10. Install injection pump, as outlined.
- 11. Install water pump pulley.
- 12. Install power steering pump bracket and tighten to specifications.
- 13. Install power steering pump and drive belt.
- Install A/C compressor mounting bracket.
   Tighten mounting bracket bolts to specification.
- 15. Install A/C compressor and drive belt.
- 16. Install alternator and vacuum pump drive belts.
- Adjust alternator, vacuum pump, A/C compressor and power steering pump drive belts to specifications. Refer to Section 03-05, Accessory Drive Belt Service.
- 18. Connect ground cables to both batteries.
- Remove intake manifold cover and install air cleaner and tighten to specification.
- 20. Run engine and check for fuel, oil, and coolant leaks.
- If necessary, purge high pressure fuel pipes of air by loosening connector one half to one turn and cranking engine until bubble-free fuel flows from connection.

CAUTION: Keep eyes and hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

### Crankcase Depression Regulator (CDR)

#### Removal

- Open hood on F-250—F-350. Remove engine cover on E-250—E-350.
- Remove air cleaner and install Intake Manifold Cover T83T-9424-A or equivalent, onto intake manifold opening.
- Remove two bolts attaching CDR valve to intake manifold and remove valve.



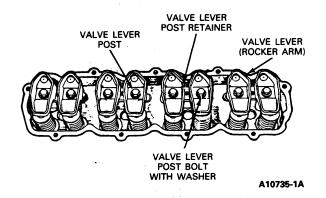
### Installation

- Install new seal ring, backup ring and O-rings onto CDR valve and install valve into crankcase vent tube.
- 2. Install two CDR valve attaching bolts into intake manifold and tighten to specification.
- 3. Install air cleaner and tighten to specification.
- Close hood or install engine cover as required.

### Valve Cover, Rocker Arm, and Push Rod Removal

- 1. Disconnect ground cables from both batteries.
- 2. On E-250—E-350, remove fan shroud. Refer to Section 03-03, Engine Cooling.
- 3. Remove engine cover (E-250—E-350 only).
- Perform steps 4 through 9 on E-250—E-350, RH side only: Remove engine oil dipstick tube fasteners and remove dipstick, tube assembly and valve cover bracket.
- 5. Remove transmission filler tube fasteners and remove filler tube and dipstick.
- 6. Raise vehicle.
- Remove nuts attaching RH engine mount insulator to frame.
- Slightly raise RH side of the engine until fuel filter header touches vehicle sheet metal. Install suitable wood block between insulator and frame. Lower engine on block.
- 9. Lower vehicle.
- Remove valve cover attaching screws and remove covers.
- 11. Remove valve rocker arm post mounting bolts.

### Valve Rocker Arm Assembly

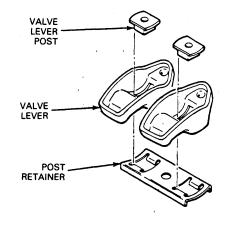


 Remove valve rocker arms and posts in order and identify so they are returned to their original positions.

NOTE: It is not necessary to disassemble the rocker arms from their pedestal assemblies to inspect them. Inspect rocker arms by rotating to the maximum position and view the post area from the underside.

13. Remove push rods in order and identify so they are returned to their original positions.

### **Rocker Arm Assembly**



A10736-1A

### Installation

 Install push rods in their original positions, making sure they are fully seated in tappet push rod seats.

NOTE: Install copper colored end of push rod toward rocker arm.

- Install valve rocker arms and posts in their original positions. Apply Multi-Purpose grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent, to valve stem tips.
- Install valve rocker arm post attaching bolts as follows:

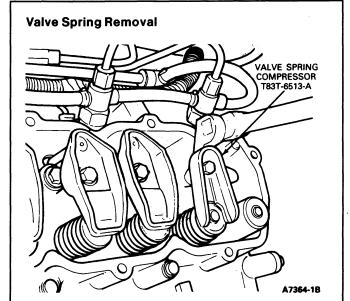
- Turn engine over by hand until timing mark is at 11:00 o'clock position as viewed from front of engine.
- b. Install all rocker arm post attaching bolts, and tighten to 27 N·m (20 ft-lb).
- Clean valve covers with clean solvent and install new gaskets.
- 5. Install valve covers on cylinder heads. Tighten attaching screws to 8 N-m (6 ft-lb).
- 6. Raise vehicle.
- Raise engine, remove wood block and lower engine onto No. 1 crossmember, if required.
- 8. Install insulator attaching washers and nuts and tighten to specification, if required.
- 9. Lower vehicle.
- Install transmission filler tube and tighten to specification. Install transmission oil dipstick, if required.
- Install engine oil dipstick tube and valve cover bracket. Tighten fasteners to specification. Install engine oil dipstick.
- 12. Install radiator fan shroud halves, if required. Refer to Section 03-03, Engine Cooling.
- 13. Install ground cables to both batteries.
- 14. Run engine and inspect for oil leaks.

### Valve Spring, Retainer and Stem Seal

Broken valve springs or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred. Refer to the following procedure.

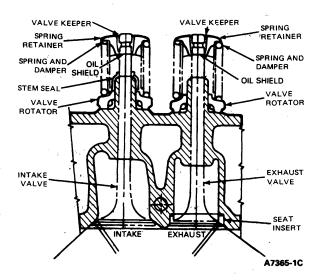
### Removal

- 1. Remove the required valve rocker arm(s).
- Remove glow plug(s) with Glow Plug Socket D83T-6002-A or equivalent.
- Install an air line with the adapter from Rotunda Compression Tester 014-00701 or equivalent, into the glow plug hole and turn on the air supply.
- Install spring compressor using Spring Compressor T83T-6513-A or equivalent, as shown. Compress valve spring and remove retainer locks, oil shield spring retainer, valve spring and damper spring.



NOTE: It may be necessary to strike valve stem end with a plastic tipped hammer to loosen valve retainer locks.

### Valve Spring Assembly



- 5. Remove valve stem seal and valve rotators.
- 6. Air pressure will force the piston to bottom of the cylinder and any removal of air pressure will allow valve(s) to fall into cylinder. A rubber band, tape or string wrapped around end of valve stem will prevent this condition and will still allow enough travel to check the valve for binding.

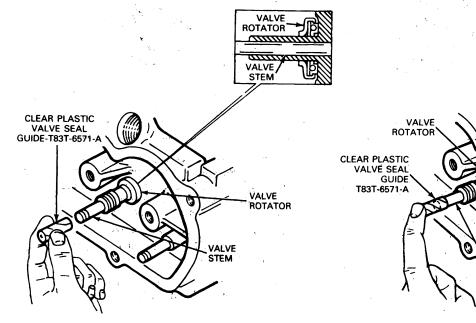
### Installation

Inspect cylinder head and valve assemblies, as outlined. Inspect the valve stem for damage. Rotate the valve and check valve stem tip for eccentric movement during rotation. Move valve up and down through normal travel in valve guide and check stem for binds. If valve has been damaged, it will be necessary to remove cylinder head for repairs, as outlined. Inspect valve retainer locks for excessive wear, and replace in pairs, as necessary.

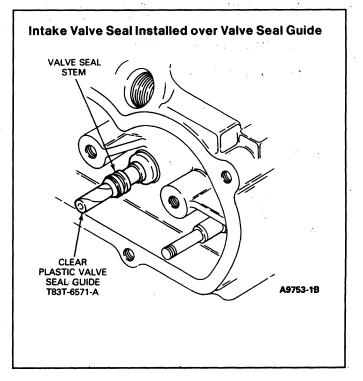
NOTE: When installing a new valve, always use new retainer locks.

- If condition of valve proved satisfactory, hold valve in closed position and pressurize cylinder by applying compressed air to adapter installed in glow plug hole.
- Lubricate valve stem with recommended engine 3.
- Install valve rotators as shown.

### Valve Seal Guide Installation

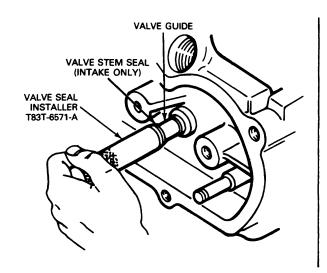


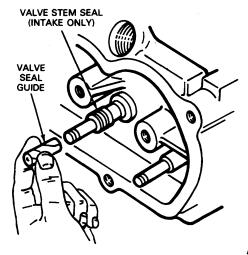
For the intake valves only, install valve stem seals by installing the clear plastic valve seal guide. Install the valve stem seal by hand until it rests on the end of the valve guide. Use Valve Stem Seal Replacer T83T-6571-A or equivalent to align the seal over the end of the valve guide as shown.



A9752-2A

### Installing Valve Stem Seal Using Installer Tool T83T-6571-A





A9754-2B

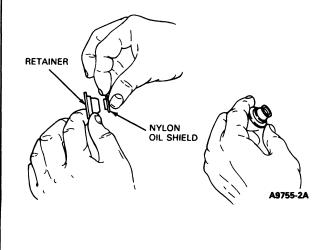
CAUTION: Apply only steady hand pressure on Valve Stem Seal Replacer T83T-6571-A or equivalent until the seal bottoms squarely on the valve guide.

 Remove the plastic valve seal guide. Install the nylon oil shield into the valve spring retainer, applying pressure on shield until it snaps into place.

CAUTION: If the nylon oil shield is not properly installed in the valve spring retainer, it will float and cause excessive oil consumption.

NOTE: Intake and exhaust valve stem oil shields are different. The intake valve oil shield is much smaller than the exhaust valve oil shield. These oil shields are not interchangeable.

### Installing Nylon Oil Shield



- Place spring in position over valve and install valve spring retainer assembly. Compress valve spring and install valve spring retainer locks.
   Verify that the locks are correctly seated.
   Remove valve spring compressor.
- Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A), or equivalent, to tips of valve stem and push rods.
- Install required rocker arm(s) and push rod(s) following instructions under Rocker Arm Installation.
- Install glow plugs using Glow Plug Socket D83T-6002-A or equivalent, and tighten to 16 N·m (12 ft-lb).

### **Fuel Supply Pump**

### Removal

- Loosen threaded connections with proper size wrench (flare nut wrench preferred) and tighten snugly. Do not remove lines at this time.
- Loosen mounting bolts one to two turns. Apply force with hand to loosen fuel pump if gasket is stuck. Rotate engine, by "nudging" starter, until fuel pump cam lobe is at low position. At this position, spring tension against fuel pump bolts will be greatly reduced.
- Disconnect fuel supply pump inlet, outlet, and fuel return line.

### WARNING: USE CARE TO PREVENT COMBUSTION OF SPILLED FUEL.

 Remove fuel pump attaching bolts. Remove pump and gasket. Discard old gasket.

### Installation

- Remove all fuel pump gasket material from engine and from fuel supply pump if installing original pump.
- Install attaching bolts into fuel supply pump and install a new gasket onto bolts. Position fuel supply pump to mounting pad. Turn attaching bolts alternately and evenly. Tighten to specification.

NOTE: Cam must be at low position before attempting to install fuel supply pump. If it is difficult to start the mounting bolts due to spring action of the fuel pump, turn crankshaft by hand 360 degrees to relocate camshaft lobe. Then, proceed with fuel supply pump installation. Install with lever on bottom side of cam.

- Install fuel outlet line. Start fitting by hand to avoid crossthreading. Tighten to specification.
- Install inlet line and tighten hose clamp to specification.
- 5. Start engine and observe all connections for fuel leaks for two minutes.
- Stop engine and check all fuel supply pump fuel line connections. Check for oil leaks at pump mounting pad.

### **Injection Pump**

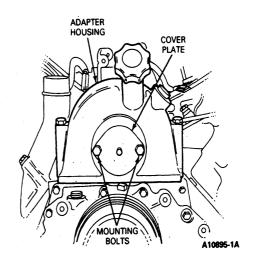
NOTE: Before removing any fuel lines, clean exterior with clean fuel oil or solvent to prevent entry of dirt into engine when fuel lines are removed.

CAUTION: Do not wash or steam clean engine while engine is running or still hot from running. Serious damage to injection pump could occur.

### Removal

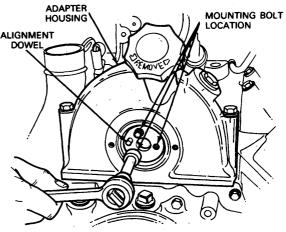
- Disconnect battery ground cables from both batteries.
- 2. Remove engine cover on E-250—E-350.
- Remove adapter housing cover plate by removing two retaining bolts.

### **Adapter Housing and Cover Plate**



Remove bolts attaching injection pump to drive gear.

### **Injection Pump Drive Gear Attaching Bolts**

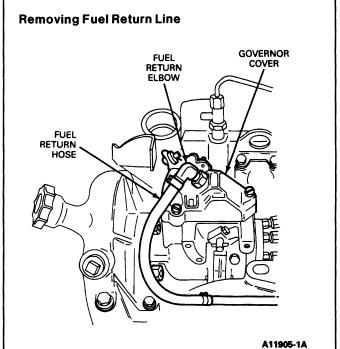


A11903-1B

- Disconnect electrical connectors to injection pump.
- 6. Remove fast idle solenoid bracket assembly to provide access to injection pump mounting nuts.

# FAST IDLE SOLENOID BRACKET MOUNTING BOLTS

- RIGHT SIDE VIEW
  - A11904-1A
- 7. Disconnect accelerator cable and speed control cable from throttle lever, if so equipped.
- Remove air cleaner and install intake opening cover, using Intake Manifold Cover T83T-9424-A, or equivalent.
- Remove accelerator cable bracket (with cables attached) from intake manifold and position out of the way.
  - NOTE: All fuel lines and fittings must be capped using Fuel System Protective Cap Set T83T-9395-A or equivalent, to prevent fuel contamination.
- 10. On E-250—E-350, disconnect fuel inlet line from the fuel filter.
- 11. On E-250—E-350, disconnect fuel return line from fuel filter.
- 12. On E-250—E-350, remove fuel filter bracket attaching bolts and remove fuel filter and bracket as an assembly.
- Remove fuel return hose and clip from the 90 degree elbow at the governor cover. Cap opening at governor cover elbow.



14. Remove fuel filter-to-injection pump fuel line and

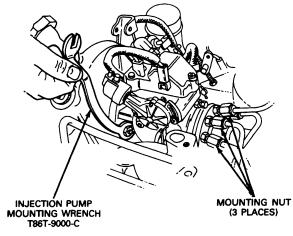
cap fittings.

NOTE: It is not necessary to remove injection lines from injection pump to remove injection pump. If lines are to be removed, loosen injection line fittings at injection pump before removing it

- 15. Remove fuel injection lines from nozzles and cap lines and nozzles.
- Remove three nuts attaching injection pump to injection pump drive gear cover using Injection Pump Mounting Wrench T86T-9000-C or equivalent.

### **Injection Pump Mounting Nut Removal**

from engine.

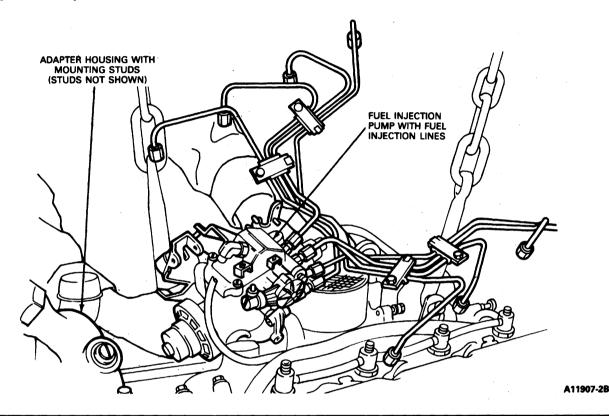


A11906-1A

- 17. If injection pump is to be replaced, loosen injection line retaining clips and injection nozzle fuel lines with Fuel Line Nut Wrench T83T-9396-A or equivalent, and cap all fittings at this time with Fuel System Protective Cap Set T83T-9395-A or equivalent. Do not install injection nozzle fuel lines until new pump is installed in engine.
- On F-250, F-350 and F-Super Duty—Stripped Chassis, lift injection pump, with nozzle lines attached, up and out of engine compartment.

CAUTION: Do not carry injection pump by injection nozzle fuel lines as this could cause lines to bend or crimp.

### **Injection Pump Removal**



 On E-250—E-350, remove injection pump through passenger compartment.

NOTE: Use care to avoid spilling diesel fuel in passenger compartment.

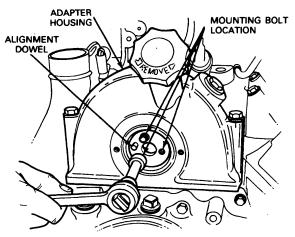
CAUTION: Do not carry injection pump by injection nozzle fuel lines as this could cause lines to bend or crimp.

### Installation

 Install new O-ring onto drive gear end of injection pump.

- 2. On F-250—F-350—F-Series Stripped Chassis, move injection pump down and into position.
- On E-250—E-350, install injection pump from passenger compartment.
  - NOTE: Use care to avoid spilling diesel fuel in passenger compartment.
- Position alignment dowel on injection pump into alignment hole on drive gear. If necessary, rotate pump drive shaft to align drive slot prior to installation.

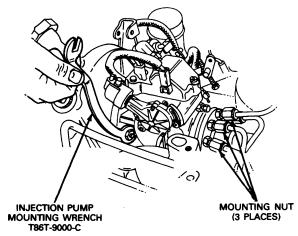
### **Injection Pump Drive Gear Attaching Bolts**



A11903-1B

- Install bolts attaching injection pump to drive gear and tighten to specification.
- Install nuts attaching injection pump to adapter. Align scribe lines on injection pump flange and injection pump adapter. Tighten nuts to specification using injection pump mount wrench T86T-9000-C or equivalent.

### **Injection Pump Mounting Nut Removal**



A11906-1A

- If injection nozzle fuel lines were removed from injection pump, install at this time. Refer to Injection Nozzle Fuel Lines, Installation.
- Remove caps from nozzles and fuel lines. Install fuel line nuts onto nozzles and tighten to specification using Fuel Line Nut Wrench Tool T83T-9396-A or equivalent.
- Connect fuel inlet line from filter and fuel return line to injection pump and tighten nuts to specifications.

- Install injection pump fitting adapter with a new O-ring.
- 11. Clean old sealant from injection pump elbow threads using clean solvent, and dry thoroughly. Start elbow into injection pump adapter, and then apply a light coating of Pipe Sealant With Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent, on elbow threads.
- Tighten elbow in injection pump adapter to a minimum of 8 N·m (6 ft-lb). Then tighten further, if necessary, to align elbow with injection pump fuel inlet line, but do not exceed 360 degrees of rotation or 13 N·m (10 ft-lb).
- 13. Remove caps and connect fuel filter-to-injection pump fuel line and tighten to specification.
- On E-250—E-350, install fuel filter and bracket as an assembly and tighten bolts to specifications.
- 15. On E-250—E-350, install fuel filter return line and tighten clamp to specifications.
- On E-250—E-350, install fuel filter inlet fuel line and tighten to specifications.
- Install accelerator cable bracket to intake manifold and tighten to specifications.
- Remove intake manifold cover and install air cleaner and tighten to specifications.
- Connect accelerator and speed control cable, if so equipped, to throttle lever.
- Install fast idle solenoid bracket assembly and tighten to specification.
- 21. Install electrical connectors on injection pump.
- Clean adapter housing cover plate sealing surfaces.
- Apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant, D6AZ-19562-AA (ESB-M4G92-A), or equivalent in adapter housing grooves.

NOTE: When applying Silicone Rubber Sealant, D6AZ-19562-AA (ESB-M4G92-A) or equivalent always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to "set-up", and sealing effectiveness may be reduced.

- 24. Connect ground cables to both batteries.
- Run engine and check for fuel leaks.
- If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

CAUTION: Keep eyes and hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

 Check and adjust injection pump timing as described in the Engine / Emissions Diagnosis\* manual.

### **Injection Nozzle Fuel Lines**

### Removal

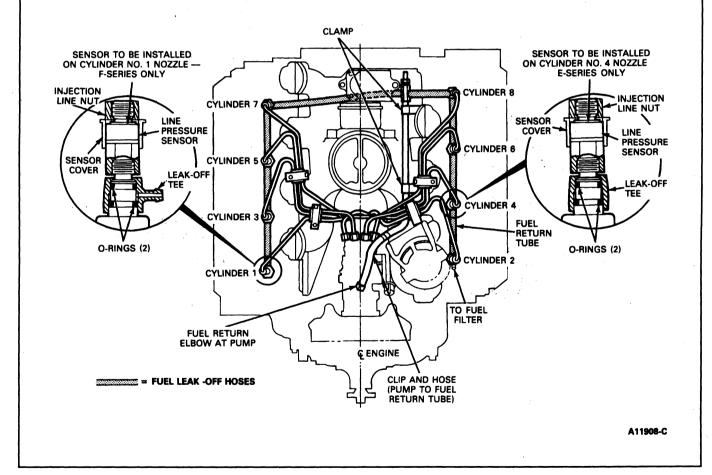
NOTE: Before removing any fuel lines, clean exterior of each nozzle assembly and surrounding area with solvent to prevent entry of dirt into fuel system when fuel lines are removed. Blow dry with compressed air.

- Disconnect ground cables from both batteries.
- 2. On E-250—E-350, remove engine cover.
- Remove air cleaner and cap intake manifold opening with Intake Manifold Cover T83T-9424-A or equivalent.

- 4. Disconnect accelerator cable and speed control cable, if so equipped, from injection pump.
- Remove accelerator cable bracket from intake manifold and position out of the way with cable(s) attached.

NOTE: To prevent fuel system contamination, cap all fuel lines and fittings with Fuel System Protection Cap Set T83T-9395-A or equivalent.

- Disconnect fuel line from fuel filter to injection pump and cap all fittings.
- 7. Disconnect and cap nozzle fuel lines at nozzles.
- Remove fuel line clamps from fuel lines to be removed.

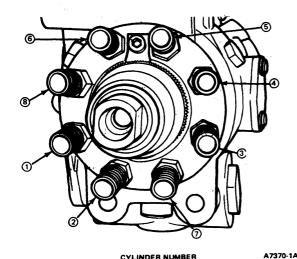


- Remove and cap injection pump inlet elbow.
- 10. Remove and cap inlet fitting adapter.

 Remove injection nozzle lines, one at a time, from injection pump using Fuel Line Nut Wrench T83T-9396-A or equivalent.

NOTE: Fuel lines must be removed following this sequence; 5-6-4-8-3-1-7-2. Install caps on each end of each fuel line and pump fitting as it is removed and identify each fuel line accordingly.

### **Injection Pump Cylinder Numbering Sequence**



### Installation

- Install fuel lines on injection pump, using Fuel Line Nut Wrench T83T-9396-A or equivalent, one at a time, and tighten to specification.
  - NOTE: Fuel lines must be installed in the sequence: 2-7-1-3-8-4-6-5.
- Clean old sealant from injection pump elbow, using clean solvent, and dry thoroughly.
- Apply a light coating of Pipe Sealant With Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent, on elbow threads.
- Install elbow in injection pump adapter and tighten to a minimum of 8 N·m (6 ft-lb). Tighten further, if necessary, to align elbow with injection pump fuel inlet line, but do not exceed 360 degrees of rotation or 13 N·m (10 ft-lb).

- Remove caps from fuel lines and connect lines to nozzles. Tighten to 30 N·m (22 ft-lb), using Fuel Line Nut Wrench T83T-9396-A or equivalent.
- 6. Uncap and connect fuel line from fuel filter to injection pump and tighten to 30 N·m (22 ft-lb).
- Install fuel line retaining clamps and tighten to specification.
- 8. Install accelerator cable bracket onto intake manifold and tighten to 51 N-m (38 ft-lb).
- Connect accelerator and speed control cable, if so equipped, to injection pump throttle lever.
- Remove intake manifold cover, and install air cleaner and tighten to 51 N-m (38 ft-lb).
- 11. On E-250—E-350, install engine cover.
- 12. Connect ground cables to both batteries.
- 13. Run engine and check for fuel leaks.
- If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

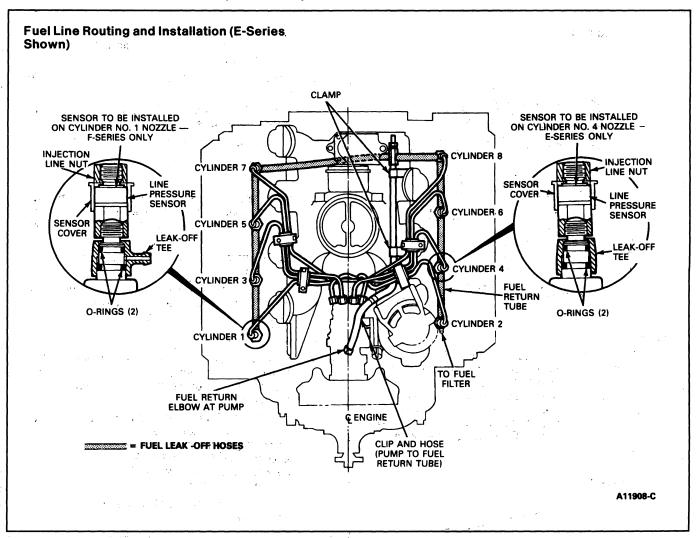
CAUTION: Keep eyes and hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

### **Injection Nozzles**

### Removal

NOTE: Before removing nozzle assemblies, clean exterior of each nozzle assembly and the surrounding area with solvent to prevent entry of dirt into engine when nozzle assemblies are removed. Also, clean fuel inlet and fuel leak-off piping connections. Blow dry with compressed air.

NOTE: On F-Series, remove and cap line sensor on number 1 cylinder to permit removal of fuel leak-off tees. On E-Series, remove and cap line sensor on number 4 cylinder to permit removal of fuel leak-off tee.



- Disconnect nozzle fuel inlet (high pressure) and fuel leak-off tees from each nozzle assembly and position out of the way. Cover open ends of fuel inlet lines and nozzles to prevent entry of dirt with Fuel System Protective Cap Set T83T-9395-A or equivalent.
- Remove fuel leak-off lines as an assembly as follows.
  - Remove pump to fuel return tube hose at fuel return elbow cap elbow at pump. Disconnect hose (from leak-off tee to fuel filter) at leak-off tee.
  - Loosen two fuel return tube retaining clamps, one at intake manifold and one at engine lifting eye. Remove fuel return hose clamp at CDR valve bracket.
  - With clamps removed, remove return lines and tees as an assembly by lifting tees off nozzles.

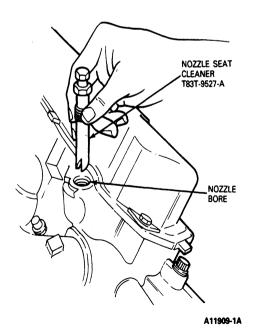
- 3. Remove injection nozzles by turning counterclockwise. Pull nozzle assembly with copper washer from engine. Be careful not to strike nozzle tip against any hard surface during removal. Cover nozzle assembly fuel inlet opening and nozzle tip with plastic cap to prevent entry of dirt, Fuel System Protective Cap Set T83T-9395-A or equivalent.
  - NOTE: Remove copper injector nozzle gasket from nozzle bore with O-Ring T71P-19703-C or equivalent, if not attached to nozzle tip.
- 4. Place nozzle assemblies in a fabricated holder as they are removed from the heads. The holder should be marked with numbers corresponding to the cylinder numbering of the engine. Use of this holder permits nozzle installation into original location in the cylinder heads.

## PLASTIC CAP LEAVE PLASTIC CAPS ON NOZZLES BETWEEN ALL SERVICE OPERATIONS A7371-1A

### Installation

 Thoroughly clean nozzle bore in cylinder head before reinserting nozzle assembly with Nozzle Seat Cleaner T83T-9527-A or equivalent. Pay particular attention to seating surface, in order that no small particles of metal or carbon will cause assembly to be cocked or permit blow-by of combustion gases. Blow out particles with compressed air.

### **Cleaning Nozzle Seats**



 Remove protective cap and install a new copper gasket nozzle assembly, with a small dab of Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent. NOTE: Anti-Seize Compound or equivalent should be used on nozzle threads to aid installation and future removal.

Install nozzle assembly into cylinder head nozzle bore.

CAUTION: Be careful that nozzle tip does not strike against recess wall.

- Tighten nozzle assembly to 47 N·m (35 ft-lb).
- Remove protective caps from nozzle assemblies and fuel lines.
- Install leak-off tees and lines as an assembly by lowering onto nozzles. Connect clip and hose to fuel return elbow at pump. Install line to retaining clamps.

NOTE: Install two new O-ring seals for each fuel return tee.

- Connect high pressure fuel line(s) and tighten to specification using Fuel Line Nut Wrench T83T-9396-A or equivalent.
- 8. Start engine.
- If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

CAUTION: Keep eyes and hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

Check for fuel leakage at high-pressure connections.

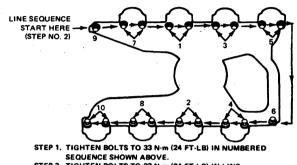
### Intake Manifold, Valley Pan and Tappets Removal

- 1. Disconnect ground cables from both batteries.
- 2. On E-250—E-350, remove engine cover.
- Remove air cleaner and install intake manifold cover, using Intake Manifold Cover T83T-9424-A or equivalent.
- On E-250—E-350, disconnect fuel inlet line from the fuel filter.
- On E-250—E-350, disconnect fuel return line from fuel filter.
- On E-250—E-350, remove fuel filter bracket attaching bolts and remove fuel filter and bracket as an assembly.
- 7. Remove injection pump, as outlined.
- On F-250—F-350, remove fuel return hoses from No. 7 and No. 8 (rear) nozzles and remove return hose to fuel tank.
- Remove glow plug harness and controller.
   Remove engine wiring harness from engine.

NOTE: Remove engine harness ground cable from back of left cylinder head.

 Remove bolts attaching intake manifold to cylinder heads and remove manifold.

### Intake Manifold Attaching Bolts Tightening Sequence



SEQUENCE SHOWN ABOVE.

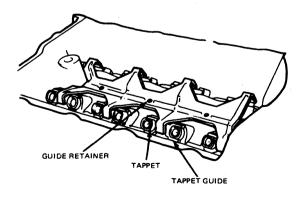
STEP 2. TIGHTEN BOLTS TO 33 N·m (24 FT-LB) IN LINE
SEQUENCE SHOWN ABOVE.

A75

- 11. Remove CDR tube and grommet from valley pan.
- 12. Remove bolts attaching valley pan strap to front of engine block, and remove strap.
- Remove valley pan drain plug and remove valley pan.
- If tappets are being serviced, remove valve covers, rocker arms and push rods, as outlined.
- 15. Remove tappet guide retainer.

NOTE: Tappets should be kept in order so they can be installed in their original position. Inspect and test each tappet separately to prevent intermixing the internal parts.

### **Tappet Removal**



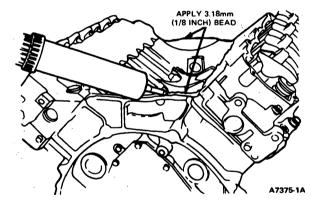
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### Installation

- Lubricate tappets and bores with recommended quality engine oil and install tappets in their original positions.
- 2. Install tappet guides.
- Install tappet guide retainer and tighten to specifications.
- Position push rods, copper colored ends toward rocker arms, into their respective tappets making sure they are seated fully in push rod seats.
- Install rocker arms and valve covers with new gaskets, as outlined.
- Clean cylinder block gasket surfaces of any old Silicone Rubber Sealant or oil. Apply a 3.18mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent, to each end of the cylinder block.

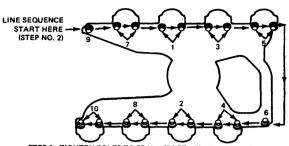
NOTE: When applying Silicone Rubber Sealant always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to "set-up", and sealing effectiveness may be reduced.

### **Applying Silicone Rubber Sealant**



- 7. Install new valley pan.
- 8. Install valley pan drain plug.
- 9. Install CDR tube and new grommet into valley pan.
- Install new O-ring and new back-up ring on CDR valve.
- Install valley pan strap onto front of valley pan and tighten to specification in Standard Torque Chart.
- Install intake manifold and tighten to specifications using the two-step method shown.

### Intake Manifold Attaching Bolts Tightening Sequence

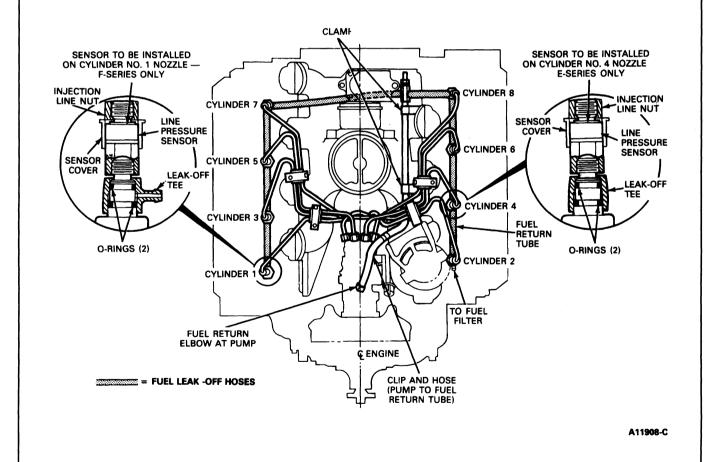


STEP 1. TIGHTEN BOLTS TO 33 N·m (24 FT·LB) IN NUMBERED SEQUENCE SHOWN AROUS

STEP 2. TIGHTEN BOLTS TO 33 N·m (24 FT-LB) IN LINE SEQUENCE SHOWN ABOVE.

### Fuel Line Routing and Installation (E-Series Shown)

- Install engine wiring harness on engine.
   NOTE: Connect engine wiring harness ground wire to rear of left cylinder head and tighten to specification.
- 14. Install glow plug controller and harness.
- On E-250—E-350, install fuel filter and bracket as an assembly and tighten bolts to 33-52 N·m (24-39 ft-lb).
- 16. On E-250—E-350, install fuel filter return line and tighten clamp to specifications.
- 17. On E-250—E-350, install fuel filter inlet fuel line and tighten to specifications.
- 18. Install injection pump, as outlined.
- Connect fuel tank return hose and No. 7 and No. 8 nozzle fuel return hoses.



- 20. Remove intake manifold cover and install air cleaner. Tighten to specification.
- 21. Install engine cover, E-250-E-350.
- 22. Connect ground cables to both batteries.
- 23. Run engine. Check for oil and fuel leaks.
- If necessary, purge nozzle high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from the connection.

CAUTION: Keep eyes and hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

### **Exhaust Manifolds**

### F-250 - F-350 - F-Super Duty

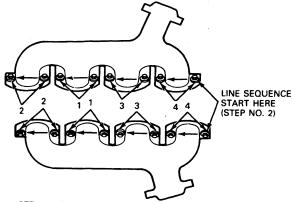
### Removal

- 1. Disconnect ground cables from both batteries.
- 2. Raise vehicle.
- Disconnect muffler inlet pipe from exhaust manifolds.
- If right exhaust manifold is to be removed, lower vehicle at this time. If left exhaust manifold is to be removed, leave hoist up.
- Remove exhaust manifold attaching bolts and manifold.

### Installation

- 1. Clean mounting surfaces.
- Apply anti-seize compound on exhaust manifold bolt threads and install left manifold with new gasket.
- Tighten bolts to specifications, using the two-step method shown. Raise vehicle.
- If right exhaust manifold is being installed, raise vehicle at this time, and repeat installation steps 2 and 3.

### **Exhaust Manifold Tightening Sequence**



STEP1. TIGHTEN BOLTS TO 47 N·m (35 FT-LB),IN NUMBERED SEQUENCE SHOWN ABOVE.

STEP2. TIGHTEN BOLTS TO 47 N·m (35 FT-LB),IN LINE SEQUENCE SHOWN ABOVE.

A7912-1B

- 5. Connect muffler inlet pipe to manifolds and tighten to specification.
- 6. Lower vehicle.

- 7. Connect battery ground cables to both batteries.
- 8. Run engine and check for exhaust leaks.

### E-250-E-350

### Removal

- 1. Open hood. Remove engine cover.
- Disconnect battery ground cables from both batteries.
- 3. For RH manifold only, remove radiator fan shroud halves. Refer to Section 03-03, Engine Cooling.
- 4. For RH manifold only, remove engine oil dipstick tube fasteners. Remove dipstick and tube.
- For RH manifold only, remove transmission filler tube fasteners. Remove filler tube and dipstick.
- 6. Raise vehicle.
- For RH manifold only, remove nuts attaching RH engine mount insulator to frame.
- For RH manifold only, slightly raise RH side of the engine until fuel filter header touches vehicle sheet metal. Install suitable wood block between insulator and frame. Lower engine on block.
- 9. Remove muffler inlet pipe from exhaust manifolds.
- 10. Lower vehicle.
- 11. Remove bolts and manifold.

### Installation

- Apply anti-seize compound to manifold retaining bolts. Install manifold with new gasket.
- 2. Tighten bolts to specifications using the two-step method shown previously for F-Series.
- 3. Raise vehicle.
- For RH manifold only, raise engine, remove wood block and lower engine onto No. 1 crossmember.
- For RH manifold only, install insulator attaching washers and nuts. Tighten to specification.
- Install muffler inlet pipe to exhaust manifolds and tighten to specification.
- Lower vehicle.
- For RH manifold, install transmission filler tube and tighten to specification. Install transmission oil dipstick.
- Install engine oil dipstick tube and tighten fasteners to specification. Install engine oil dipstick.
- For RH manifold, install radiator fan shroud halves. Refer to Section 03-03, Engine Cooling.
- 11. Connect ground cables to both batteries.
- 12. Run engine and check for exhaust leaks.
- 13. Install engine cover and close hood.

### **Thermostat**

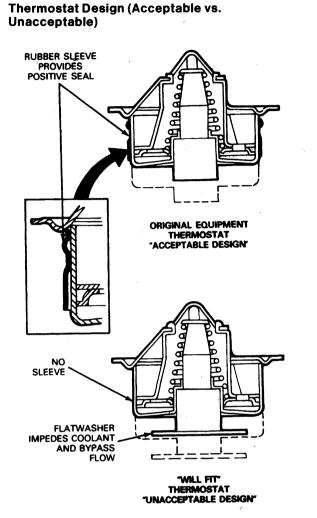
A poppet-type thermostat is used with the engine. When the thermostat is closed, coolant flows to the water pump through a bypass passage at the front of the engine. When the thermostat is open, coolant flows through the coolant outlet elbow (thermostat housing) to the radiator.

CAUTION: Replacement thermostats other than the specified Motorcraft, or Navistar thermostats may result in engine overheat damage. The specified thermostat does not contain an internal bypass, since the by-pass is located in the cylinder block. Therefore, whenever the thermostat is replaced, it is mandatory that only Motorcraft E5TZ-8575-C or Navistar 1807945-C1 thermostat be installed.

The thermostat is a high temperature thermostat for use with a mixture of water and permanent-type anti-freeze.

CAUTION: Do not attempt to repair the thermostat. It should be replaced if it is not operating properly.

Check the thermostat before installing it, following the procedure described in this section.



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### Removal

- . Disconnect ground cables from both batteries.
- Drain coolant from radiator until coolant level is below thermostat. Refer to Section 03-03, Engine Cooling.
- Loosen and remove alternator and vacuum pump drive belts.
- Remove alternator. Position alternator out of the way.
- Remove vacuum pump and bracket. Position pump out of the way.
- Remove all but the lowest alternator / vacuum pump mounting casting bolt. Loosen the lowest bolt and pivot the alternator / vacuum pump casting outboard.
- Remove the water outlet housing attaching bolts.
   Bend the radiator upper hose upward and remove the thermostat and gasket.

### Installation

- Clean the water outlet housing gasket surfaces.
   Coat a new outlet housing gasket with Perfect
   Seal Sealing Compound B5A-19554-A
   (ESR-M18P2-A), or equivalent. Position the water
   outlet housing gasket on intake manifold opening.
- Install thermostat in crankcase opening with the copper pellet or element toward engine and the thermostat flange positioned in the recess. If thermostat is improperly installed, it will cause a restricted flow of coolant.
- Position the water outlet housing against the crankcase. Install and tighten the attaching bolts to specification.
- 4. Reposition the alternator / vacuum pump casting. Install attaching bolts.
- Install vacuum pump with bracket and tighten to specification.
- 6. Install alternator and drive belt.
- 7. Install vacuum pump drive belt.
- Adjust alternator and vacuum pump drive belts to specification. Refer to Section 03-05, Belt Accessory Drive Service.
- Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling.
- 10. Connect ground cables to both batteries.
- 11. Operate the engine until normal operating temperature is reached, then check the coolant level. Inspect cooling system for leaks.

WARNING: DO NOT STAND IN LINE OR NEAR RADIATOR FAN WHEN REVVING ENGINE.

### **Cylinder Heads**

### RH Side Described, LH Side Similar

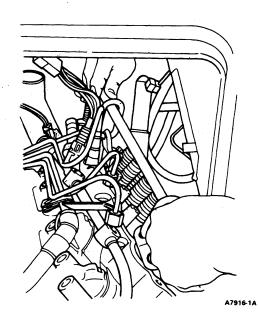
### Removal

- 1. Disconnect ground cables from both batteries.
- Drain cooling system.
- Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- Remove radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents.

CAUTION: LH thread. Remove by turning nut clockwise.

- Disconnect alternator wiring from alternator. Disconnect wiring harness electric connector from top of fuel filter/fuel heater/water separator.
- Remove alternator adjusting bolt and pivot bolt. Remove alternator.
- 7. Remove vacuum pump adjusting bolt and pivot bolt. Remove vacuum pump.
- Remove fuel filter inlet, outlet and return lines. Cap lines and fittings with Fuel System Protection Cap Set T83T-9395-A or equivalent, (F-250—F-350, RH side only).
- Remove alternator and vacuum pump mounting bracket. On F-250—F-350, remove fuel filter bracket with filter attached (RH side only).
- 10. Remove heater hose from cylinder head.
- 11. Remove injection pump, as outlined.
- Remove intake manifold and valley cover, as outlined.
- 13. Raise vehicle.
- Disconnect muffler inlet pipe from exhaust manifolds.
- 15. Remove bolt attaching transmission oil dipstick tube to cylinder head (RH side only).
- 16. Lower vehicle.
- Remove engine oil dipstick tube-fasteners (RH side only).
- 18. Remove right hand exhaust manifold, as outlined.
- 19. Remove engine oil dipstick, dipstick tube and O-ring (RH side only).
- Remove valve cover, rocker arms and push rods, as outlined.
- 21. Remove nozzles and glow plugs, as outlined.
- 22. Remove bolts attaching cylinder head to engine block.
- Attach Engine Lifting Brackets T70P-6000 or equivalent, to each end of cylinder head.
- For F-250—F-350, install lifting sling to lifting eyes and carefully lift cylinder head out of engine compartment.
- 25. For E-250—E-350, install suitable bar through rings on lifting eyes. With an assistant, carefully lift cylinder head and remove.

### Cylinder Head Removal — E-250 — E-350

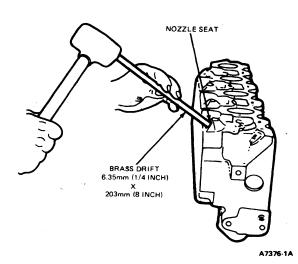


26. Remove head gasket carefully to prevent damage to cylinder head locating dowel sleeves.

CAUTION: Prechambers may fall out of cylinder head upon removal.

 Remove prechambers using a 6.35mm x 203mm (1/4 inch x 8 inch) brass drift and suitable hammer.

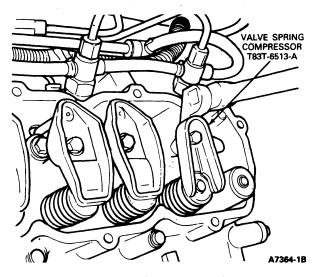
### **Prechamber Removal**



28. Place cylinder head in suitable holding Fixture. NOTE: Be careful not to damage the cylinder head gasket surface.

 Install Valve Spring Compressor T83T-6513-A or equivalent, compress valve spring, and remove valve keeper. NOTE: It may be necessary to strike valve stem end with a light, soft hammer to loosen valve keepers.

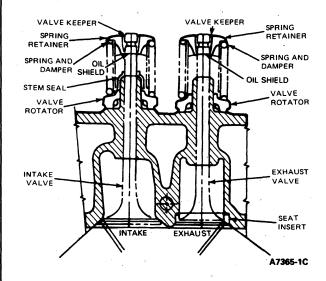
### Valve Spring Removal



 Release spring compressor and remove spring retainer, valve spring and damper assembly.

NOTE: Keep valves and their related parts together so they may be installed in their original positions.

### Valve Spring Assembly



31. Remove valve seal, valve rotators and valves.

NOTE: Remove any burrs from valve stem before removing valves to prevent damage to the valve bore.

### Installation

 Clean and inspect cylinder head and valves, as outlined.

- Clean and inspect cylinder head gasket surface for cracks and flatness, as outlined.
  - NOTE: To avoid erroneous readings, remove pre-combustion chamber inserts prior to inspection of cylinder head gasket surface.
- Install valves, springs, retainers and stem seals, as outlined.
- Clean and inspect prechambers and ports for cracks. Install or replace prechambers as necessary. Refer to Overhaul—Cylinder Head Assembly in this section.
- Apply a light coating of Steering Linkage Lube D4AZ-19590-A (ESA-M1C92-A), or equivalent, to mounting edge of prechamber and install prechamber into head. Lightly tap with plastic-tipped hammer, if necessary.
- Clean and inspect engine block head gasket surface for cracks and flatness.
- 7. Position new cylinder head gasket on engine block using locating dowels. Install gasket with silver stamped "This Side Up" facing installer.
- On F-Series, attach lifting sling and brackets to cylinder head. On E-Series, position bar through rings on lifting eyes. Carefully lower cylinder head onto engine block.
  - CAUTION: Use care when installing cylinder head to prevent pre-chambers from falling into cylinder bores. Do not slide cylinder head across gasket. Sliding head may damage seals and result in coolant or oil leakage.
- Lightly lubricate cylinder head bolt threads and mating surfaces of bolt heads and washers with engine oil.
  - CAUTION: Do not use anti-seize compounds, grease or any other lubricant except engine oil. Other lubricants have an adverse effect on torque value.
- Install cylinder head retaining bolts and washers.
   Tighten to specifications as shown.

### Cylinder Head Bolt Tightening Sequence

### SEQUENCE START HERE STEPS NO. 3 12 6 10 14 17 12 4 5 13

### **EXHAUST SIDE**

- STEP 1. TIGHTEN BOLTS TO 88 N·m (65 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.
- STEP 2. TIGHTEN BOLTS TO 115 N·m (85 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.
- STEP 3. TIGHTEN BOLTS TO 136 N·m (100 FT-LB) IN LINE SEQUENCE SHOWN ABOVE.
- STEP 4. REPEAT STEP NO. 3.

A7913-1C

- Install push rods, copper colored ends toward rocker arms, making sure push rods are fully seated into tappets.
- 12. Install rocker arms and valve covers, as outlined.
- 13. Install valley pan and intake manifold, as outlined.
- 14. Install injection pump, as outlined.
- 15. Connect heater hose to cylinder head and tighten clamp to specification.
- Install fuel filter/fuel heater/water separator with bracket (F-250—F-350, RH side only), and/or alternator and vacuum pump bracket and tighten to specification.
- Remove protective caps and install fuel filter inlet, outlet and return lines. Tighten to specifications.
- Loosely install engine oil dipstick tube and O-ring into cylinder block (RH side only).
- 19. Raise vehicle.
- Install RH hand exhaust manifold, as outlined. Install fasteners holding engine oil dipstick tube in position.
- Install bolt attaching transmission oil dipstick to cylinder block and tighten to specification (RH side only).
- Connect muffler inlet pipe to exhaust manifolds and tighten to specification.
- 23. Lower vehicle.
- 24. Install vacuum pump.
- 25. Install alternator and drive belt.
- 26. Install vacuum pump and drive belt.
- Adjust alternator and vacuum pump drive belts to specifications. Refer to Section 03-05, Belt Accessory Drive Service.

- Connect alternator wiring harness. Connect wiring harness top of fuel filter / fuel heater / water expansion.
- Remove intake manifold cover and install air cleaner. Tighten to specification.
- 30. Connect ground cables to both batteries.
- 31. Refill and bleed cooling system. Refer to Section 03-03, Engine Cooling.
- Run engine and check for fuel, coolant and exhaust leaks.
- If necessary, purge high-pressure fuel lines of air by loosening connector one half to one turn and cranking engine until bubble-free fuel flows from connection.
  - CAUTION: Keep eyes and hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.
- 34. Install radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents.
  - CAUTION: LH thread. Tighten by turning nut counterclockwise.
- Install radiator fan shroud. Refer to Section 03-03, Engine Cooling.

### **Engine Oil Filter**

### Removal

- 1. Raise vehicle.
- 2. Remove oil filter, using a suitable oil filter wrench.

### Installation

- Clean gasket mating surface on oil filter flange.
- 2. Lightly coat sealing gasket with clean engine oil.
- Install oil filter until seal contacts filter flange and tighten 1 1/4 to 2 additional turns.
- Lower vehicle.
- Check engine oil level, and add as required.
- 6. Run engine and check for oil leaks.

### **Engine Oil Cooler**

CAUTION: Do not start the engine after a debris generated failure without replacing the oil cooler bundle. Debris cannot be filtered before entering the oil cooler since the filter is downstream of the cooler.

NOTE: If necessary refer to Oil Cooler Leakage Test and perform as outlined.

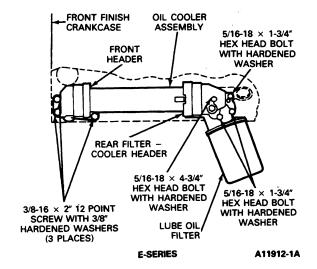
### Removal

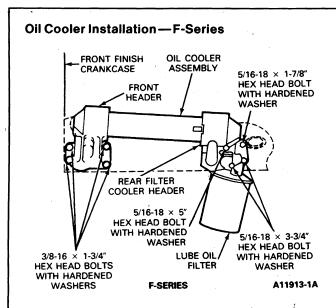
- 1. Disconnect ground cables from both batteries.
- 2. Drain cooling system.
- 3. Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B, or equivalents.

CAUTION: LH thread. Remove by turning nut clockwise.

- Raise vehicle.
- Drain engine oil and remove oil filter. Do not install drain plug.
- Remove nut attaching LH engine mount insulator to frame (F-250—F-350 only).
- Slightly raise LH side of the engine and install a 25mm (one inch) wood block between insulator and frame. Lower engine on block (F-250—F-350 only).
- Remove bolts attaching oil cooler to engine block and remove engine oil cooler.

### Oil Cooler Installation E-Series





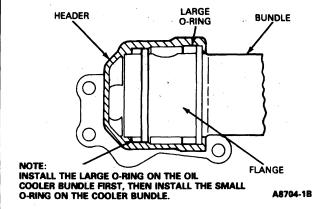
### Installation

 Assemble cooler and headers. Install engine oil cooler assembly with new gaskets and tighten to specification.

NOTE: Four O-rings are used on all oil coolers (F-Series and E-Series).

CAUTION: The inner O-ring must be installed on the header (not on the bundle) to avoid cutting the inner O-ring during assembly.

### Oil Cooler Tube Installed in Header



- Raise engine, remove wood block and lower engine onto No. 1 crossmember (F-250—F-350 only).
- 3. Install insulator attaching washer and nut. Tighten to specification (F-250—F-350 only).
- Lubricate oil filter gasket and install new oil filter until seal contacts filter flange. Tighten filter 1 1/4 to 2 additional turns. Install drain plug and tighten to specification.
- Prime the entire engine lubricating system to fill the oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.

NOTE: Priming the lubricating system will minimize the possibility of scuffing or heat build-up during initial engine operation which could lead to immediate or low mileage failure.

- Lower vehicle.
- Check the engine oil level and fill as necessary with the specified pe and grade of oil.
- 8. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling.
- Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents.

### CAUTION: LH thread. Turn nut counterclockwise to tighten.

Tighten nut to specifications.

- Install radiator fan shroud. Refer to Section 03-03, Engine Cooling.
- 11. Connect ground cables at both batteries.
- 12. Run engine and check for oil and coolant leaks.

### Oil Pan, Oil Pump and Oil Pick-Up Tube Removal

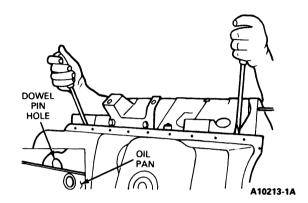
- 1. Disconnect ground cables from both batteries.
- 2. Remove engine oil level dipstick.
- 3. Remove transmission oil level dipstick, if so equipped.
- Remove air cleaner and intake tube and intake opening using Intake Manifold Cover T83T-9424-A or equivalent.
- Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents. Position the fan out of the way, in the fan shroud.

### CAUTION: LH thread. Remove by turning nut counterclockwise.

- 6. Drain cooling system.
- 7. Disconnect the upper lower radiator hoses.
- Disconnect power steering return hose from pump. Plug hose and pump to prevent contamination of the system.
- Disconnect alternator and A/C compressor wiring harness and fuel line heater connector from alternator. Position the harness away from the engine.
- 10. Raise vehicle.
- Disconnect and plug transmission oil cooler lines from radiator, if so equipped.
- 12. Disconnect and plug fuel pump inlet fuel hose.
- 13. Drain crankcase and remove oil filter.

- Disconnect muffler inlet pipe from exhaust manifolds.
- 15. Disconnect muffler inlet pipe at muffler flange, disconnect the hanger bracket at the frame rail and remove inlet pipe.

### Oil Pan Removal



- Remove upper inlet pipe mounting stud from right exhaust manifold.
- Remove bolt attaching transmission oil filler tube to engine block and remove tube.
- Remove nuts and washers attaching engine insulators to No. 1 crossmember.
- Remove the two bolts securing the shift linkage bell crank to the transmission (automatic transmission). Let the linkage hang freely.
- 20. Lower vehicle.
- E-250—E-350: Install Rotunda Engine Lifting Brackets 014-00312 or equivalent, to front of engine. Connect Engine Lifting Brackets T70P-6000 or equivalent, to lifting sling and raise engine until transmission housing contacts body.
  - F-250—F-350: Install lifting sling to lifting eyes on intake manifold and raise engine until transmission housing contacts body.
- Install wood blocks (approximately 2 3/4 inch LH side, 2 inch RH side) between engine insulators and crossmember.
- 23. Lower engine onto blocks to support the engine.
- 24. Raise vehicle.
- 25. Remove flywheel inspection plate.
- Position fuel pump inlet line at rear of No. 1
  crossmember. Remove transmission oil cooler
  lines, if so equipped, and position out of way.
- 27. Remove oil pan attaching bolts.
- 28. Remove the transmission mount retaining nuts and raise the transmission approximately 2.54cm (1 inch) using a suitable transmission jack.
- 29. Remove oil pump and pick-up tube from engine and lay in oil pan (F-250—F-350 only).

30. Remove oil pan.

NOTE: Oil pan is gasketless. Pan is sealed to crankcase with silicone gasket material. To remove, insert two screwdrivers through crankcase dowel holes on LH side of crankcase and pry oil pan off.

NOTE: Crankshaft may have to be turned to reposition counterweights to aid in removal of oil pan.

31. Remove oil pump pickup tube from oil pump, if required.

NOTE: E-250—E-350, oil pump can be removed at this time, if necessary.

### Installation

- Remove old gasket material. Clean mating surfaces of oil pan, engine block and front and rear covers with a suitable solvent and dry thoroughly.
- Clean mating surfaces of oil pickup tube. Inspect for cracks, and assemble to oil pump with new gasket, if removed. Tighten nuts to specification.
   NOTE: Prime oil pump with recommended engine oil. Rotate pump drive gear to distribute oil within pump body.
- E-250—E-350, install oil pump and tighten bolts to specification, if removed.
- 4. Place oil pump and pick-up tube in oil pan.
- 5. Place oil pan in position on No. 1 crossmember.
- Install oil pump and pick-up tube and tighten to specifications (F-250—F-350 only).
- Apply a 3.16mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent, on side rails of engine block oil pan mating surface, and a 6.35mm (1/4 inch) bead of Silicone Rubber Sealant D6AZ-19562-AA or BA (ESB-M4G92-A), or equivalent, on ends of engine oil pan mating surface on front and rear covers, and in mating corners.

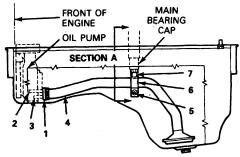
NOTE: When applying Silicone Rubber Sealant always use the bead size specified and join the components within 15 minutes of application.

After 15 minutes, sealant begins to "set-up" and sealing effectiveness may be reduced.

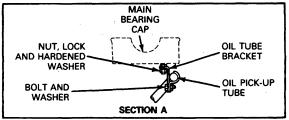
- Install locally fabricated oil pan installation dowels in position.
- Position oil pan onto engine and install attaching bolts.
- Remove oil pan locating dowels and install two remaining oil pan bolts. Tighten all oil pan retaining bolts to specifications.
- Lower transmission and install the transmission mount retaining nuts. Tighten nuts to 96-128 N-m (70-94 ft-lb).
- Install flywheel inspection plate and tighten to specifications.

### Lower vehicle.

### Oil Pick-Up Tube Installation

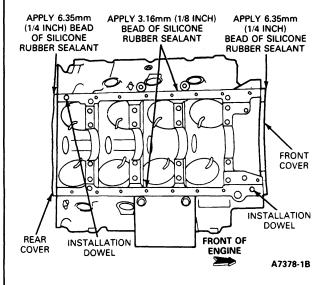


- 1. OIL PICK-UP TUBE MOUNTING GASKET 2. 5/16"-18 × 2" BOLT AND 5/16" HARDENED
- WASHER
- 3. 5/16"-18 × 1-1/2" BOLT AND 5/16" HARDENED WASHER
- OIL PICK-UP TUBE ASSEMBLY
- 5. 5/16"-18 × 0.930 BOLT W/WASHER 6. OIL TUBE BRACKET
- 5/16"-18 NUT AND 5/16" LOCK AND HARDENED WASHERS



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### **Applying Silicone Rubber Sealant and Installation Dowels**



- 14. Raise engine and remove wooden engine support
- 15. Lower engine onto No. 1 crossmember and remove lifting sling.

- Raise vehicle.
- 17. Position the automatic transmission filler tube (with a new "O" ring) and install the retaining bolts. Tighten bolt to specifications.
- 18. Install nuts and washers attaching engine insulators to No. 1 crossmember and tighten to specifications.
- 19. On automatic transmission equipped vehicles, position the shift linkage bell crank to the transmission and tighten the bolts to 27-40 N·m (20-30 ft-lb).
- 20. Install upper muffler inlet pipe mounting stud on right exhaust manifold.
- 21. Position muffler inlet pipe and hanger in vehicle and connect muffler inlet pipe to muffler flange, using a new gasket, and tighten to specification.
- 22. Connect muffler inlet pipe to exhaust manifolds and tighten to specification. Tighten hanger bracket nuts to specifications.
- 23. Install oil pan drain plug and new oil filter. Tighten to specifications.
- 24. Connect fuel pump inlet hose to fuel pump and tighten to specification.
  - NOTE: Make sure fuel line clip is installed in No. 1 crossmember.
- 25. Connect transmission oil cooler lines, if so equipped, and tighten to specification.
- 26. Lower vehicle.
- 27. Connect alternator and A/C compressor wiring harness to alternator and compressor. Connect wiring harness to top of fuel filter / fuel heater/water separator.
- 28. Connect power steering return hose to power steering pump.
- 29. Connect upper and lower radiator hoses and tighten clamps to specification.
- 30. Install radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents, and tighten to specification.

### **CAUTION: LH thread. Install by turning nut** counterclockwise.

- 31. Remove intake manifold cover, and install air cleaner and intake tube. Tighten to specifications.
- 32. Install engine oil and transmission oil dipsticks.
- 33. Refill and bleed cooling system. Refer to Section 03-03, Cooling System Service.
- 34. Fill crankcase with specified quantity, and viscosity of engine oil.
- 35. Connect ground cables to both batteries.
- 36. Run engine and check for oil, fuel and coolant leaks.
- 37. Check power steering fluid and add, if necessary.

### Overhaul

NOTE: Engine must be removed from chassis for piston or crankshaft service.

NOTE: Crankshaft and piston cooling jets must be removed prior to cylinder, or piston/ring service. Piston cooling jets could be damaged by cylinder deglazing or honing operations.

NOTE: When assembling the engine during overhaul it is important to prelubricate the running parts with clean engine oil to assure initial lubrication when the engine is started. To further assure complete initial lubrication, the engine lubricating system should be pressure primed or charged with oil. Priming the lubricating system will minimize the possibility of scuffing or heat build-up during initial engine operation, which could lead to immediate or low mileage failure.

### **Cylinder Assembly**

### **Disassembly**

- Mount the old engine on a work stand using Rotunda Engine Stand Mounting Adapters 014-00306 or equivalent, and remove all parts not furnished with new cylinder assembly. Follow applicable Removal and Installation procedures in this section.
- Remove four cylinder head locating dowels and block drain plugs.
- Remove old cylinder assembly from work stand.

### **Assembly**

- Clean gasket and seal surfaces of all serviceable parts and assemblies with a suitable solvent and dry thoroughly.
- Position new cylinder assembly on a work stand and install cylinder head locating dowels and block drain plugs.
- Transfer all serviceable parts removed from original cylinder assembly, following procedures described under Removal and Installation in this section.
- Check all assembly clearances. Ensure that clearances are in accordance with Specifications listed at end of this section. Service as necessary.

### Cylinder Block

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs, following procedures outlined.

### Disassembly

- Mount old engine in a work stand using Rotunda Engine Stand Mounting Adapters 014-00306 or equivalent. Completely disassemble engine following procedures described under Removal and Installation in this section.
- Ridge-ream cylinder bores before removing piston assemblies.

 Remove cylinder head locating dowels and block drain plugs.

### **Assembly**

- Clean gasket and seal surfaces of all serviceable parts and assemblies with a suitable solvent and dry thoroughly.
- Position new cylinder block in a work stand and install cylinder head locating dowels and block drain plugs.
- Transfer all serviceable parts removed from original cylinder block following procedures described under Removal and Installation in this section.
- Check all assembly clearances. Ensure that clearances are in accordance with Specifications at end of this section. Service as necessary.

### **Pistons and Connecting Rods**

NOTE: Do not use a power wrench for removing or installing connecting rod bolts, nuts and washers. Power wrench usage will cause seizure of connecting rod bolt or nut threads.

### Removal

- With engine removed from vehicle and placed on an engine stand as outlined under Cylinder Assembly, remove injection pump, intake manifold, cylinder heads, oil pan, and oil pump as outlined.
- 2. Remove any ridges and / or deposits from upper end of cylinder bores as follows:
  - a. Turn crankshaft until piston to be removed is at the bottom of its travel. Place a cloth on piston head to collect cuttings. Remove any ridge and/or deposits from upper end of cylinder bores. Remove cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer.

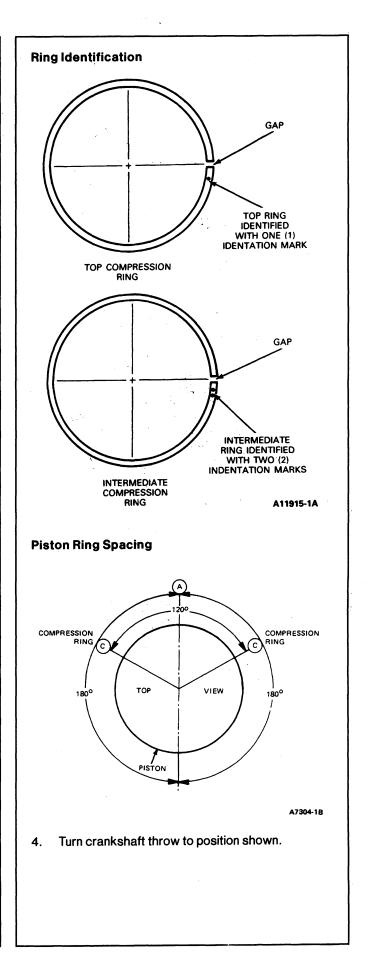
CAUTION: Never cut into ring travel area. Maximum cylinder ridge cutter depth is 0.79mm (0.031 inch).

- Mark all connecting rods and caps to permit installation into original positions.
- Turn crankshaft until connecting rod being removed is down (BDC).
- 5. Remove connecting rod nuts and cap.
- Install Connecting Rod Installation Guides D83T-6136-A or equivalent onto connecting rod bolts.
- Push connecting rod and piston assembly out top of cylinder with handle end of a hammer. Avoid damage to cooling jets, crankshaft journal or cylinder wall when removing piston and rod.

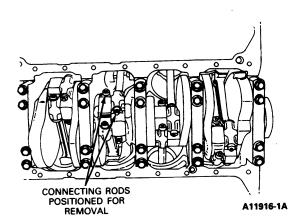
- Remove bearing inserts from connecting rod and cap, if required.
- Install cap onto connecting rod from which it was removed.

### Installation

- If new piston rings are to be installed, remove cylinder wall glaze. Follow instructions of the tool manufacturer. Cylinder bores must be cleaned with a soap and water solution after deglazing or honing. Dry and oil cylinder walls immediately after cleaning as outlined. Use proper size ring installer tool.
- 2. Oil piston rings, pistons, and cylinder walls with specified engine oil. Be sure to install pistons in same cylinders from which they were removed, or to which they were fitted. Connecting rods and bearing caps must be numbered 1, 3, 5, 7, in left bank, beginning at front of engine. The numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with a new cylinder number.
- Piston rings are identified by indents as shown.
   Make sure ring gaps (oil ring spacer-A, oil ring-B, compression ring-C) are properly spaced around circumference of piston.

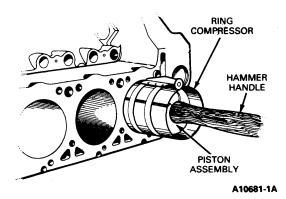


### **Positioning Connector Rods for Removal**

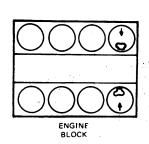


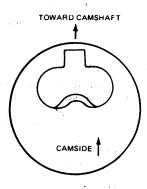
5. Install connecting rod upper bearing. Install Connecting Rod Installation Guides D83T-6136-A or equivalent. Before installing, verify that large chamfer on connecting rod faces crankshaft check (facing toward front on engine on right bank rods, and toward rear of engine on left bank rods). Install Piston Ring Compressor D81L-6002-C or equivalent, onto piston and push piston in with a hammer handle until it is slightly below top of cylinder. Guide connecting rods to avoid damaging cooling jets and crankshaft journals. Install piston with arrow and eyebrows on piston head toward camshaft.

### Installing Piston — Typical



### **Piston Orientation**





A7379-1C

- Push piston downward until connecting rod bearing seats on crankshaft journal. Remove protective sleeves and install lower bearing and cap.
- Check clearance of each bearing and connecting rod side clearance following procedure described under Main and Connecting Rod Bearings.
- After bearings have been fitted, apply a light coat of specified engine oil to journals and bearings.
- Install connecting rod cap and bearing. Tighten connecting rod nuts alternately to 52 N·m (38 ft-lb). Tighten nuts to 69 N·m (51 ft-lb).

NOTE: Lightly coat bolt threads with oil before installing.

### Crankshaft

### Removal

- With engine removed from vehicle and placed on an engine stand as outlined under Cylinder Assembly remove injection pump and adapter, engine front and rear covers, oil pan, oil pump and pick up, as outlined.
- Mark all bearing caps (main and connecting rod) to permit installation into their original locations.
- Turn crankshaft until connecting rod from which cap is being removed is down (BDC), and remove bearing cap. Install Connecting Rod Installation Guides D83T-6136-A or equivalent, and push connecting rod and piston assembly up into cylinder. Remove rod and piston from cylinder. Remove guides and install bearing cap. Repeat this procedure until all connecting rods are removed.

CAUTION: Use care to avoid damage to crankshaft journal, cooling jets and cylinder wall when moving piston assembly.

 Remove main bearing caps. Main bearing caps are numbered from front of engine.

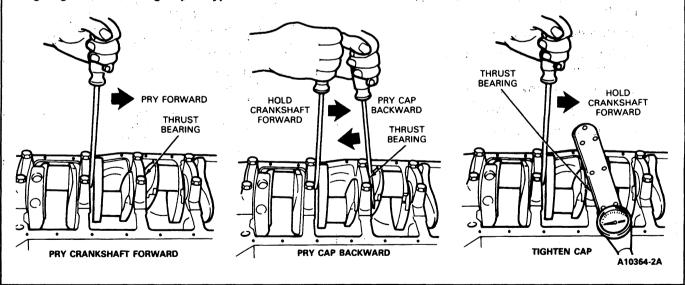
 Install Engine Lifting Brackets T70P-6000 or equivalent, to crankshaft and carefully lift crankshaft out of block so that thrust bearing surfaces are not damaged. Handle crankshaft with care to avoid possible fracture or damage to finished surfaces. (Refer to Cleaning and Inspection.)

### Installation

- Remove main bearing inserts from block and bearing caps.
- Clean mating surfaces of block and main bearing caps.
- Remove connecting rod bearing inserts from connecting rods and caps.
- 4. If crankshaft main bearing journals have been refinished to a definite undersize, install correct undersize bearings. Ensure bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearings and cause failure.
- Place upper main bearing inserts with tangs fitting in slots, and oil holes into position in bores. Do not install thrust bearing (No. 3 main bearing) at this time.
- Install lower main bearing inserts into bearing caps.

- 7. Carefully lower crankshaft into place. Handle crankshaft with care to avoid possible fracture or damage to finished surfaces. If necessary refer to Cleaning and Inspection.
- 8. Remove lifting eyes.
- Install upper No. 3 main bearing (thrust flanges and oil hole) by rolling main bearing into saddle.
- Check clearance of each main bearing following procedure under Fitting Main and Connecting Rod Bearings.
- Apply specified engine oil to journals and bearings.
- Install all bearing caps, except thrust bearing cap (No. 3 bearing). Be sure that main bearing caps are installed in their original locations. Tighten bearing cap bolts to specification.
- 13. Install thrust bearing cap with bolts finger-tight.
- Pry crankshaft forward against thrust surface of upper half of bearing.
- Hold crankshaft forward and pry thrust bearing cap to rear. This will align thrust surfaces of both halves of bearing.
- Retain forward pressure on crankshaft. Tighten cap bolts to specification.
- 17. Force crankshaft toward rear of engine.
- 18. Check crankshaft end play as outlined.

### Aligning Thrust Bearing Cap — Typical



### Camshaft

### Removal

1. Remove engine from vehicle as outlined.

- With engine placed on an engine stand as outlined under Cylinder Assembly, remove injection pump and adapter, intake manifold and tappets, engine front cover and fuel supply pump as outlined.
- Remove camshaft drive gear, fuel supply pump cam, spacer and thrust plate from the camshaft as outlined.

Carefully remove camshaft.

CAUTION: Use care to avoid damaging camshaft bearings.

### Installation

Coat camshaft lobes with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent, and lubricate journals with specified engine oil before installation.

- Oil camshaft journals and apply Multi- Purpose Grease DOAZ-19584-AA (ESR-M1C159-A), or equivalent, to lobes. Carefully slide camshaft through bearings. If tools are available, a handle may be fabricated for easier installation of camshaft by connecting the Puller Screw Extension from Camshaft Bearing Set T65L-6250-A into Camshaft Installation Adapter D83T-6250-A or equivalent. This assembly is then connected onto the end of the camshaft prior to installation. Remove the handle assembly when camshaft is properly seated in the bearings. Install new camshaft thrust plate onto cylinder block and tighten to specification.
- Install spacer and fuel pump cam against camshaft thrust flange using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent.
- Install camshaft drive gear against fuel pump cam, aligning timing mark with timing mark on crankshaft drivegear using Crank / Cam Gear and Damper Replacer T83T-6316-B or equivalent.
- 4. Install camshaft allen screw and tighten to 20 N-m (15 ft-lb).
- 5. Install fuel supply pump, as outlined.
- Install new crankshaft oil seal in engine front cover as outlined.
- 7. Install engine front cover as outlined.
- 8. Install water pump as outlined.
- 9. Install injection pump adapter as outlined.

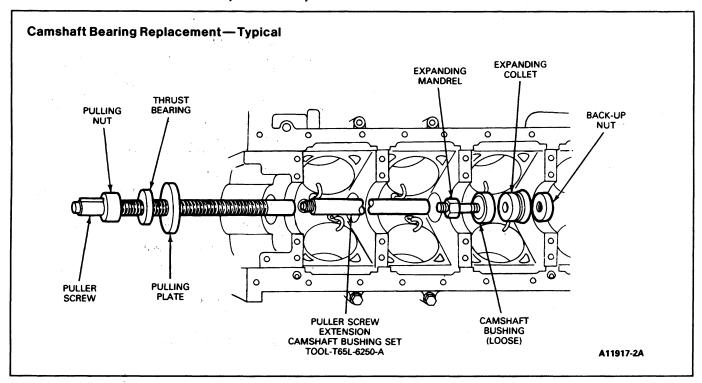
- Lubricate tappets and bores with specified engine oil and install tappets in their original positions.
- 11. Install tappet guides.
- Install tappet guide retainer and tighten to specification.
- Position push rods, copper colored ends toward rocker arms, into their respective tappets making sure they are seated fully in push rod seats.
- Install rocker arms and valve covers with new gaskets as outlined.
- 15. Install intake manifold as outlined.
- 16. Install injection pump as outlined.
- 17. Install engine into vehicle as outlined.

### Camshaft Bearings

The bearings are interchangeable from one bore to another except for the front bearing which is wider than the others.

### Removal

- Remove engine from vehicle as outlined. Mount engine stand using Rotunda Engine Stand Mounting Adapter 014-00306 or equivalent.
- Remove camshaft, flywheel and crankshaft, following appropriate procedures in this section. Push pistons to top of cylinders.
  - CAUTION: Use care when pushing pistons to top of cylinders to prevent damage to piston cooling jets. Use Connecting Rod Installation Guides D83T-6136-A or equivalent, protect connecting rod bolts.
- Using Camshaft Bearing Set T65L-6250-A or equivalent, select proper size expanding collet and backup nut and assemble on expanding mandrel. With expanding collet collapsed, install collet assembly in camshaft bearing, and tighten back-up nut on expanding mandrel until collet fits camshaft bearing.



- 4. Assemble puller screw and extension, if necessary, as shown and install on expanding mandrel. Wrap a cloth around threads of puller screw to protect front bearing or journal. Tighten pulling nut against thrust bearing and pulling plate to remove camshaft bearing. Be sure to hold wrench on end of puller screw to prevent it from turning.
- Repeat procedure for each bearing. To remove front bearing, install puller screw from rear of cylinder block.

### Installation

- Position new bearings at bearing bores with oil holes aligned, and press in place with Camshaft Bearing Set T65L-6250-A or equivalent shown under Removal. Be sure to center pulling plate and puller screw to avoid damage to bearing.
   Failure to use correct expanding collet can cause severe bearing damage. Be sure front bearing is installed the specified distance below front face of cylinder block.
- Install camshaft, crankshaft, flywheel and related parts, as outlined. It is not necessary to check connecting and main bearing clearances as a part of Camshaft Bearing Replacement.
- Install engine into vehicle as outlined.

### **Core Plugs**

### **Removal and Installation**

To remove a large core plug, drill a 12.70mm (1/2 inch) hole in the center of plug and remove with Impact Slide Hammer T59L-100-B, T50T-100-A or equivalent, or pry it out with a large drift punch. On a small core plug, drill a 6.35mm (1/4-inch) hole in center of plug and pry it out with a small pin punch. Clean and inspect plug bore.

Prior to installing a core plug, plug bore should be inspected for any damage that would interfere with proper sealing of plug. If the bore is damaged it will be necessary to true surface by boring for next specified oversized plug.

Oversize (OS) plugs are identified by OS stamped in flat located on cup side of plug.

Coat plug and / or bore lightly with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A), or equivalent, and install it following procedure for cup type or expansion type below:

### **Cup-Type**

Cup-type core plugs are installed with flanged edge outward. Maximum diameter of plug is located at outer edge of flange. Flange on cup-type plugs flares outward with largest diameter at outer (sealing) edge.

CAUTION: It is important to pull plug sealing edge into machined bore by using a properly sized socket. Under no circumstances is plug to be driven into bore using a tool that contacts flange. This method will damage sealing edge and will result in leakage and/or plug blow out.

Flanged (trailing) edge must be below chamfered edge of bore to effectively seal plugged bore.

If core plug replacing tool has a depth seating surface, do not seat tool against a non-machined (casting) surface.

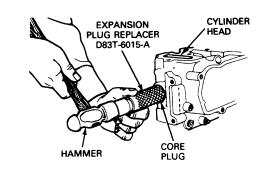
### **Expansion-Type**

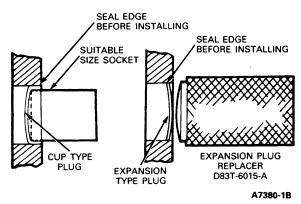
Expansion-type core plugs are installed with (dished) edge inward flush with bottom edge of chamfer.

Coat edges of plug with a suitable non-hardening sealing compound and install using Expansion Plug Replacer D83T-6015-A or equivalent, and hammer. When installed, trailing (maximum) diameter must be below edge of bore to effectively seal bore.

NOTE: For in-vehicle repair, use commercially available closure plugs until engine is removed for overhaul.

### **Typical Core Plugs and Installation Tool**





### Cylinder Head

New cylinder head assemblies are interchangeable from one cylinder bank to another. Used cylinder heads should be installed into their original positions using new gaskets. Cylinder head gaskets are interchangeable.

- Clean gasket surface. Remove all burrs or scratches with an oil stone.
- Check for warpage or cracks. Replace head if warped or cracked.

NOTE: Cylinder heads are not to be resurfaced.

### Replacing Valve Guides

Excessive guide clearance prevents adequate cooling of valve through guide and allows valve to tilt or tip which may cause valve breakage at high engine speed. These conditions prevent good seating and promote leakage past valve face. If valve guides are either larger than specified or damaged, use Valve Guide Tools D83T-6085-A or equivalent, and follow manufacturer's instructions. Install as follows:

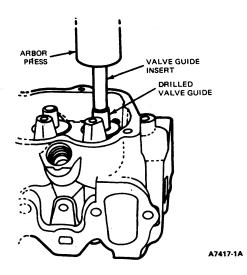
- Drill out valve guide.
- Ream drilled guide bore for recommended insert sleeve.

NOTE: Before installing inserts they should be thoroughly chilled with dry ice or other means to facilitate their installation in the cylinder head.

 Chill repair insert in dry ice. Carefully press insert into bore.

NOTE: When installing repair insert, be careful not to burr ID of insert.

### **Installing Valve Guide Insert**



 Finish insert with recommended size reamers to specified valve guide diameter. Always re-face valve seat after valve guide has been reamed, and use suitable scraper to break sharp corner (ID) at top of valve guide.

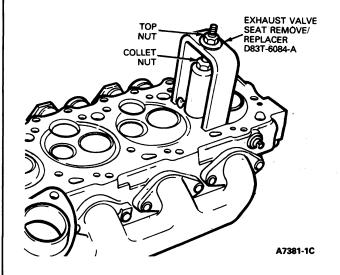
### **Valve Seats**

Prior to seat reconditioning, clean seats and inspect for cracks, burning or other damage. Inspect exhaust seat inserts for looseness.

### Removal — Exhaust Seats

 Use Exhaust Valve Seat Remover / Replacer D83T-6084-A or equivalent, to remove damaged or loose seats. Position removal collet into insert and rotate collet nut clockwise to expand collet jaws under lip of seat insert.

### **Exhaust Seat Insert Removal**

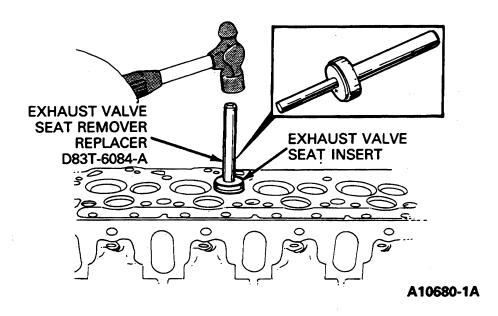


Rotate top nut clockwise to remove insert.
 NOTE: If an oversize seat insert is required, the cylinder head should be sent out to a qualified machine shop for insert counterbore procedure.

### Installation

 Install valve seat using Exhaust Valve Seat Remover / Replacer D83T-6084-A or equivalent, and a hammer. Valve seat inserts supplied for service are standard size, .015 inch oversize and .030 inch oversize.

### **Installing Exhaust Seat Insert**



### **Refacing Valve Seats**

Refacing of valve seat should be closely coordinated with refacing of valve face so that finished seat and valve face will be concentric and specified interference fit will be maintained. This is important so that valve and seat will have a compression tight fit. Ensure that valve seat grinding wheels are properly dressed.

Grind valve seats to specification. Remove only enough stock to clean up pits and grooves or to correct valve seat runout. After seat has been refaced, use seat width scale or machinist scale to measure seat width. Narrow seat, if necessary to bring it within specification. Refer to specifications.

If valve seat width exceeds maximum limit, remove enough stock from top edge and/or bottom edge of seat to reduce width to specification.

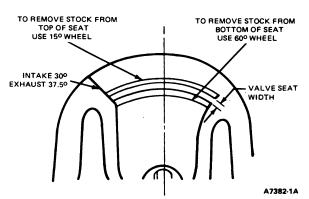
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### REMOVAL AND INSTALLATION (Continued)

### Checking Valve Seat Width—Typical SEAT WIDTH SCALE

Use a 60 degree angle grinding wheel to remove stock from bottom of seats (raise seats) and use a 15 degree angle wheel to remove stock from top of seats (lower seats).

### **Refacing Valve Seat**



Finished valve seat should contact approximate center of valve face. It is good practice to determine where valve seat contacts face. To do this, coat seat with Prussian blue and set valve in place. Rotate valve with light pressure. If blue is transferred to center of valve face, contact is satisfactory. If blue is transferred to top edge of valve face, lower valve seat. If blue is transferred to bottom edge of valve face, raise valve seat. Fit of valve and seat should never be lapped out with lapping compounds.

### **Valves**

Inspect valve for evidence of burning, warping, scuffing or bending. Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged, if face runout cannot be corrected by refinishing, or if stem clearance exceeds specifications. Refer to specification.

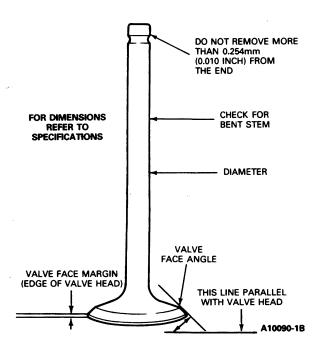
Discard any worn or damaged valve train parts.

### **Refacing Valves**

The valve refacing operation should be closely coordinated with valve seat refacing operations so that finished angles of valve face of valve seat will be to specifications and provide a compression tight fit. Be sure that valve grinding wheels are properly dressed.

If valve face runout is excessive and/or to remove pits and grooves, reface valves to specification. Remove only enough stock to correct runout or to clean up pits and grooves. If edge of intake valve head is less than 2.84mm (0.112 inch) thick after grinding, replace valve as valve will run too hot in engine. If edge of exhaust valve head is less than 1.35mm (0.053 inch) thick after grinding replace valve. Interference fit of valve and seat should not be lapped out.

### **Critical Valve Dimensions**



Remove all grooves or score marks from end of valve stem, and chamfer it as necessary. Do not remove more than 0.254mm (0.010 inch) from end of valve stem.

If valve and/or valve seat has been refaced, it will be necessary to check clearance between rocker arm pad and valve stem tip with valve train assembly installed in engine.

### **Camshaft Repair**

Remove light scuffs, scores or nicks from camshaft machined surfaces with smooth oil stone marks.

### **Crankshaft Repair**

Clean all parts with cleaning solvent, dry with compressed air, and inspect bearings for wear and evidence of uneven bearing support. If such evidence is present, examine bearing caps and supporting surfaces or crankcase for high spots and burrs.

Inspect crankshaft journals for scoring, burning and cracking. Measure diameter of each journal using a micrometer. Check dimensions obtained against Specifications. Measure each journal at two points, one at right angles to other, in order to show any evidence of out-of-round. Move micrometer over entire width of journal.

Crankshafts must not be straightened. Even slight straightening with complete absence of cracks will endanger the high strength built into the shaft.

Bearing failures can cause overheating of crankshaft journals and a reduction of hardness. When this occurs, the crankshaft strength may be unacceptably reduced. Whenever bluing is found on the journal or fillet area, the crankshaft must be replaced.

### **Crankshaft Grinding**

An induction-hardened fillet and journal crankshaft can be reground similar to any precision crankshafts. However, these shafts require special treatment when grinding. Before grinding, all crankshafts must be checked for hardness.

Crankshafts should be ground at a qualified machine shop, experienced in grinding induction hardened crankshafts. Crankshafts should be magnifluxed after grinding to insure that there are no surface cracks.

### Crankshaft Undersize Grinding Limits Grinding Limits:

Maximum allowable taper on crankpins (rod journals) and main journals .013mm (.0005 inches) per 25.4mm (1 inch) of length. Crankpins and journals must be polished to 508 Micro-mm (20 Micro-inch) maximum - to 127 Micro-mm (5 Micro-inch) minimum, and must not be over 0.003mm (0.0001 inch) out of round.

The main journal fillet radii should be 3.07 - 3.226mm (.121 - .127 inch) with the crankpins (rod journals) fillet radii held at 3.05mm (.120 inch).

The third main journal controls crankshaft end thrust and provides initial location of crankshaft in relation to crankcase. For this reason the width of the third journal must be 28.766 - 28.841mm (1.1325 - 1.1355 inch).

### Fitting Main or Connecting Rod Bearings With Plastigage

### Fitting Main Bearings.

NOTE: Be sure bearing inserts, bearing bore and mating surfaces are clean. Foreign material under inserts will distort bearing and cause incorrect readings and subsequent bearing failure.

To obtain an accurate reading using Plastigage method of checking, all bearing caps must be in place and tightened to specification.

 Remove one bearing cap and insert. Leave remaining caps tight while checking fit of bearing.

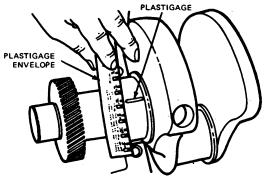
- Wipe oil from all contact surfaces such as crankshaft journal, bearing insert, bearing caps, etc.
- Place piece of Plastigage D81L-6002-B or equivalent, across full width of bearing surface on crankshaft journal (or bearing cap insert) approximately 6.35mm (1/4 inch) off center. Install bearing cap and tighten cap bolt to specification.

NOTE: Lightly coat bolt threads with oil before installing.

NOTE: Do not turn crankshaft while making check with plastigage.

- 4. Remove bearing cap and insert.
- Do not disturb Plastigage. Using Plastigage envelope, measure widest point of Plastigage. Reading indicates bearing clearance in thousandths of an inch.

### **Checking Main Bearing Clearance**



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- If the bearing clearance is not within specifications, crankshaft must be reground and undersize bearings installed.
- No. 3 crankshaft bearing controls crankshaft and provides initial location of crankshaft in relation to crankcase. Use Dial Indicator with Bracketry Tool—4201-C or equivalent, to check end play as outlined.

### **Fitting Connecting Rod Bearings**

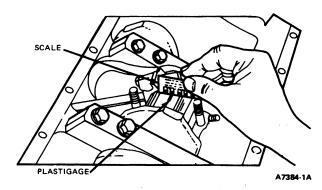
NOTE: Be sure bearing inserts, bearing bore and mating surfaces on connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause incorrect readings and subsequent bearing failure.

- Remove bearing cap and wipe oil from face of bearing insert and exposed portion of crankshaft iournal.
- Place a piece of Plastigage Tool D81L-6002-B or equivalent, on bearing surface across full width of bearing about 6.35mm (1/4 inch) off center.
- Install cap and tighten to specification.
   NOTE: Lightly coat bolt threads with oil before installing.

NOTE: Do not turn crankshaft while plastigage is in place.

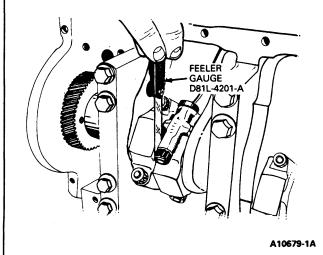
 Remove bearing cap and use Plastigage scale to measure widest point of Plastigage. Reading indicates bearing clearance in thousandths of an inch.

### **Checking Connecting Rod Bearing Clearance**



- If bearing clearance is not within specifications, crankshaft must be reground and undersize bearings installed.
- Check connecting rod end clearance using Feeler Gauge D81L-4201-A or equivalent, as shown. Excessive clearance may require replacement of rods or shaft. Check should be made to make certain specified running clearance exists. Lack of clearance could indicate damaged rod or rod bearing out of position.

### **Checking Connecting Rod End Clearance**



### Pistons, Pins and Rings

### **Fitting Pistons**

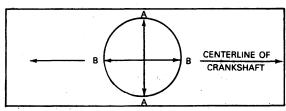
Pistons are available in standard size or oversize for service. Refer to Ford Parts Master Catalog for available oversize pistons.

Refer to Specifications for standard size piston dimensions.

CAUTION: The size piston selected should be large enough to permit cleaning up the cylinder bore and provide the proper running clearance in the cylinder bore. See Piston in Specifications in this section.

Measure cylinder bore, and select piston to assure proper clearance.

### **Cylinder Bore Measurement**



A - At Right angle to center line of engine B - Parallel to center line of engine

Top Measurement: Make 12.70mm (1/2 inch) below top of block deck

Bottom Measurement: Make within 12.70mm (1/2 inch) above top of piston - when piston is at its lowest travel (B.D.C)

Bore Service Limit: Equals the average of "A" and "B" when measured at the center of the piston travel.

Taper: Equals difference between "A" top and "A" bottom.

Out-of-Round: Equals difference between "A" and "B" when measured at the center of piston travel.

Refer to Specification tables at end of each engine section.

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After cylinder bores have been measured and recorded, measure piston diameter to ensure that specified clearance is obtained. Measure piston diameter 31.75mm (1 1/4 inches) below bottom ring land perpendicular to pin center line. It may be necessary periodically to use another piston (within same grade size) that is either slightly larger, or smaller to achieve specified clearance.

### **Piston Diameter**



If none can be fitted, refinish cylinder to provide proper clearance for piston.

NOTE: Piston cooling jets must be removed before glaze breaking cylinders. Cooling jets are reusable.

CAUTION: Special "Patch" bolts are used to install piston cooling jets. These bolts are included with new cooling jets. DO NOT use standard bolts.

When piston has been fitted, mark it for assembly in cylinder to which it was fitted.

If taper, out-of-round, and piston-to-cylinder bore clearance conditions are within specified limits, new piston rings will give satisfactory service. If new rings are to be installed in a used cylinder that has not been refinished, remove cylinder wall glaze (refer to Cylinder Block, Refinishing Cylinder Walls). Clean cylinder bore thoroughly.

If cylinder bores exceed out-of-round and/or taper specifications, reboring may be required. Such cylinder bore reconditioning will require the use of oversize service pistons. In addition to the standard size service piston .254mm (.01 inch), 508mm (.02 inch) .762mm (.03 inch) oversize pistons are available. Verify piston size by measuring skirt diameter.

- Calculate size of piston to be used by checking cylinder bore. Follow procedures described under Cleaning and Inspection.
- Select proper size piston to provide desired clearance (refer to Specifications).
- Make sure piston and cylinder block are at room temperature 21°C (70°F). After any refinishing and washing operation allow cylinder bore to cool, and make sure piston and bore are clean and dry before piston fit is checked.

### **Fitting Piston Pins**

Inspect and measure piston pins for wear. If piston pins show signs of wear, corrosion or etching replace with new pins.

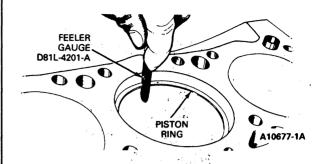
Check ID of connecting rod and piston pin bores. Replace any connecting rod or piston that is not within specifications. Piston assemblies furnished for service replacement are complete with new piston pins.

### **Fitting Rings**

NOTE: A worn ring cannot always be detected by visual inspection. Therefore, whenever a piston is removed from a cylinder, it is recommended that the piston rings be replaced.

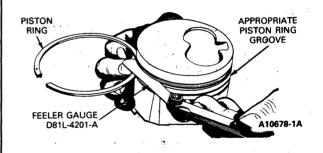
- 1. Select proper ring set for cylinder bore size.
- Position ring in cylinder bore in which it is going to be used.
- Push ring down into bore area where normal ring wear is not encountered.
- Use head of a piston to position ring in bore so that ring is square with cylinder wall. Use caution to avoid damage to ring or cylinder bore.
- Measure gap between ends of ring with Feeler Gauge D81L-4201-A or equivalent. If ring gap is less or greater than specifications, try another ring set listed under Specifications.

### **Checking Piston Ring Gap**



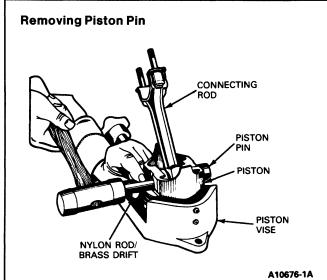
6. Check compression ring side clearance using Feeler Gauge D81L-4201-A or equivalent, inserted between ring and its lower land. Gauge should slide freely around entire ring circumference without binding. Any wear that occurs will form a step at inner portion of lower land. If lower lands have high steps, piston should be replaced.

### **Checking Piston Ring Side Clearance**



### Piston and Connection Rod Assembly Disassembly

- Remove bearing inserts from connecting rod and cap.
- Mark pistons to assure assembly with same rod and installation into cylinders from which they were removed.
- To disassemble connecting rod from piston and piston pin assembly, remove piston pin retainers from each end of pin using snap ring pliers.
- After placing piston in vise, drive pin from assembly using drift and hammer or equivalent, or brass drift and plastic tipped hammer.

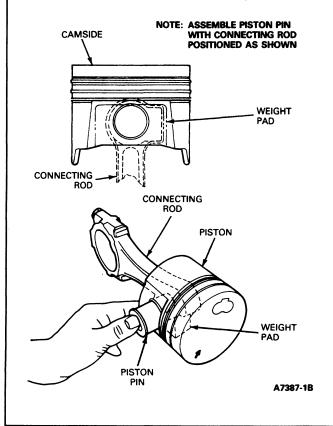


 After pin is removed, separate piston from connecting rod. Remove all old rings from piston. Clean and inspect components as described in this section.

### **Assembly**

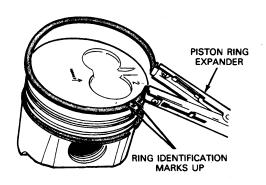
 To assemble piston to connecting rod, position rod into piston so that connecting rod weight pad and large chamfered side is located against crankshaft face and top of piston's arrow faces camside.

### **Piston and Connection Rod Assembly**



- Lubricate piston pin with specified engine oil.
   Align rod bore and piston bore and insert piston pin. Push piston pin with thumb and install retainer snap rings. Ensure that retainer rings seat fully in their grooves.
- After checking piston ring end gap as outlined assemble rings onto pistons to which they were fitted by using a suitable ring expander tool. This type of tool is recommended to avoid over expansion of rings, and also to expand rings to a true circle to avoid distortion.
- Check ring side clearance as outlined.

### Installing Piston Ring Using Suitable Piston Ring Expander Tool



IMPORTANT: INSTALL IN ORDER:
OIL CONTROL RING,
2ND COMPRESSION RING AND
TOP COMPRESSION RING.
SPACE RING GAPS 120° APART.

A10682-1A

### **Cylinder Block**

### **Refinishing Cylinder Walls**

 To refinish cylinder walls, obtain a "flexhone" for a four (4) inch bore engine with a 120 gift rating (no color code). This type of hone looks like a wire brush with carbide balls on the ends of the bristles. Also, get a full 12-ounce container of Ford "Rust Penetrant and Inhibitor" D7AZ-19A501-AA (ESR-M99C56-A), or equivalent. This spray contains colloidal graphite and has a black appearance. Get an electric, or air-powered, drill motor with adjustable speed. A speed of about 100 RPM is required. If this speed is not available. REPAIR WILL NOT BE SUCCESSFUL.

NOTE: It is NOT necessary to remove crankshaft or piston walls, however, it is good practice to oil the rod journals and wrap them in a shop towel with tape.

 Spray cylinder wall and hone cylinder wall for about three seconds while stroking up and down twice a second. Remove the hone (ALWAYS REMOVE WITH HONE ROTATING), and wipe a portion of cylinder wall. Inspect the crosshatch pattern comparing it to the neighboring (untouched) cylinder. The crosshatch angle should be 120 to 135 degrees.

NOTE: Comparison with a "virgin" bore is the best check, provided the engine has not been repaired before. If the pattern is "flatter" than called for, increase stroke speed or slow down rotation speed. The hone will not damage the piston cooling jet and that honing to the very bottom of the cylinder is not required as the piston ring travel stops well short of the bottom of the bore. The hone must be partly removed from the block at the top of each stroke.

Continue honing the cylinder (after adjusting your technique to get required 120 to 135 degrees crosshatch) for between 10 to 15 seconds, while an assistant continuously sprays the graphite spray at the cylinder well. Do not spend more than 15 seconds (25 strokes) per bore. Wipe cylinder bore clean and inspect. The bore should have a satin-like sheen with a clearly identified crosshatch pattern of 120 to 135 degrees. Compare with a virgin bore to confirm correct angel. Repeat for remaining cylinders.

 Wash all cylinders with mild soap and water (like dish washing solution). Air dry with shop air and IMMEDIATELY oil cylinder walls to prevent corrosion.

#### **Repairing Engine Casting Holes and Porosities**

Porosity or sand hole(s) resulting in oil seepage or leakage can occur with modern casting processes. When diagnosing oil leaks, perform a complete inspection of engine and transmission. If leak is attributed to porous condition of cylinder block or sand hole(s), repairs can be made with Metallic Plastic C6AZ-19554-A (M3D35-A(E)), or an equivalent metallic plastic. Do not repair cracks with this material. Repairs with this metallic plastic must be confined to those cast iron engine component surfaces where inner wall surface is not exposed to engine coolant pressure or oil pressure. For example:

- Cylinder block surfaces extending along length of the block, upward from the oil pan rail to cylinder water jacket but not including machined areas.
- b. Lower rear face of cylinder block.
- c. Cylinder head, along rocker arm cover gasket surface.

#### Typical Cast Iron Cylinder Block Repair Areas



NOTE -- PORTIONS OF THE FRONT SURFACE THAT ARE NOT MACHINED OR NOT PART OF THE WATER JACKET ARE REPAIRABLE. SHADED AREAS MAY BE REPAIRED WITH EPOXY.



REAR AND RIGHT SIDE

HADED AREAS MAY BE REPAIRED WITH EPOXY.

A7391-1A

The following procedures should be used to repair porous areas or sand holes in cast iron:

- Clean surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut hole or porosity to a depth greater than rest of the cleaned surface. Solid metal must surround hole. Openings larger than 6.35mm (1/4 inch) should not be repaired using metallic plastic. Openings in excess of 6.35mm (1/4 inch) can be drilled, tapped and plugged using common tools. Clean repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.
- Mix Epoxy Resin base and hardener as directed on container. Stir thoroughly until uniformly mixed.
- Apply repair mixture with a suitable clean tool (putty knife, wood spoon, etc.) forcing metallic plastic into hole or porosity.
- Allow mixture to harden. This can be accomplished by two methods; heat cure with a 250 watt lamp placed 0.254mm (10 inches) from repaired surface, or air dry from 10-12 hours at temperatures above 10°C (50°F).
- 5. Sand or grind the repaired area to blend with general contour of surrounding surface.
- Paint surface to match rest of block.

#### **CLEANING AND INSPECTION**

The following cleaning and inspection procedures apply to complete engine overhaul; therefore, for partial engine overhaul or parts replacement, follow applicable component cleaning or inspection procedures.

# **Crankcase Depression Regulator (CDR)**

Refer to Truck Pre-Delivery, Maintenance and Lubrication Manual for the correct mileage interval for maintenance. Service following procedures described in this section.

#### Valve Rocker Arm Assembly

#### Cleaning

Clean all parts thoroughly.

#### Inspection

Inspect pad at valve end of rocker arms for indications of scuffing or abnormal wear. If pad is grooved, replace rocker arm. **Do not attempt to true this surface by grinding.** Check fulcrum and spherical pushrod seats for excessive wear, cracks, nicks or burrs. Inspect fulcrum seat of rocker arm post for excessive wear.

#### **Push Rods**

#### Cleaning

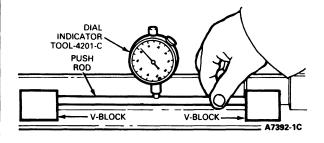
Clean all push rods in a suitable solvent. Blow out oil passage with compressed air.

#### Inspection

Check ends of push rods for nicks, grooves, roughness or excessive wear.

Push rods can be visually checked for straightness while still installed in engine by rotating them with the valve closed. They also can be checked with a Dial Indicator D78P-4201-G or equivalent.

#### **Checking Push Rod Runout**



# **Cylinder Heads**

#### Cleaning

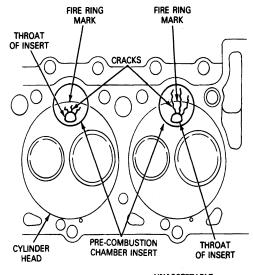
With valves installed to protect the seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage cylinder head gasket surface. After valves are removed, clean valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease and other deposits; clean all bolt holes; ensure valve seats, gasket surfaces and oil return passages are clean. Clean all valve assembly components using a suitable solvent and dry thoroughly.

#### Inspection

Examine cylinder head for cracks in combustion chambers, intake and exhaust valve ports, and around intake valve seats. Inspect exhaust valve seat inserts for looseness burned or cracked condition. Inspect gasket and sealing surfaces for scratches or mars which may cause leakage after assembly.

Pre-cup insert cracking is acceptable from the throat of the pre-combustion chamber. The cracking becomes unacceptable if the cracks extend beyond the fire ring. Acceptable and unacceptable pre-cup cracks are illustrated. Replace unacceptable pre-combustion chambers.

#### **Pre-Combustion Chamber Cracking**



ACCEPTABLE

UNACCEPTABLE CRACKS EXTEND BEYOND FIRE RING MARK

A8707-1B

Using a straight edge and a 0.15mm (0.006 inch) feeler gauge, check cylinder head gasket surface for warpage.

Replace cylinder head if it is cracked or warped.

NOTE: Cylinder heads cannot be resurfaced.

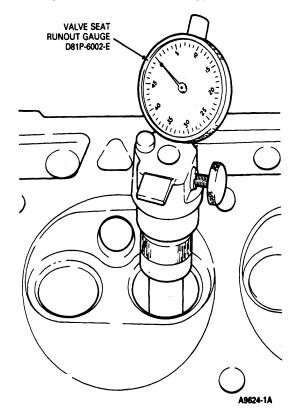
# Checking Cylinder Head Flatness 3 STRAIGHT FDGE D83L-4201-A (1) (3) CHECK DIAGONALLY A2895-1C

#### **Valve Seat Runout**

② CHECK ACROSS CENTER

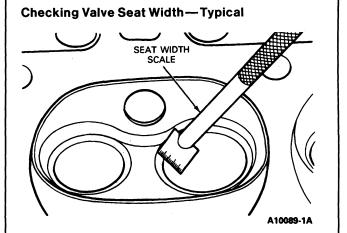
Check valve seat runout with Valve Seat Runout Gauge D81P-6002-E, or equivalent. Follow instructions of gauge manufacturer. If runout exceeds service limit, reface valve and valve seat.

#### Checking Valve Seat Runout — Typical



## **Valve Seat Width**

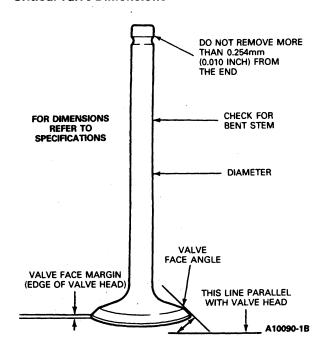
Measure valve seat width. Reface valve seat(s) as outlined if width is not within specifications.



#### **Valves**

Critical inspection points and tolerances of valve are illustrated. Refer to specifications for service limits. Remove all carbon from valve stems and valve heads using a fine wire brush or buffing wheel.

#### **Critical Valve Dimensions**



Inspect valve face and edge of valve head for pits, grooves or scores. Inspect stem for a bent condition and end of stem for grooves or scores. Check valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Visually inspect valve springs, valve spring retainers, locks and sleeves and discard any damaged parts.

Inspect valve keepers for excessive wear and replace in pairs as required. When installing a new valve, always use new valve keepers.

#### Valve Face Runout

Check valve face runout. It should not exceed specifications. If runout exceeds service limit, valve should be replaced or refaced as described under Refacing Valves.

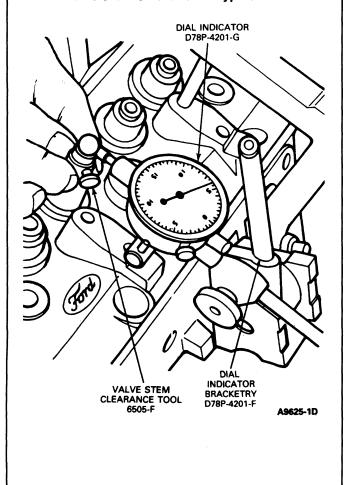
#### Valve Stem Clearance

Check valve stem to valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance TOOL-6505-F (3/8 valves); T65T-6505-H (7/16 valves); Dial Indicator D78P-4201-G, and Dial Indicator Bracket D78P-4201-F, or equivalent. Use a flat end indicator point.

Install tool onto valve stem until fully seated, and tighten knurled set screw firmly. Permit valve to drop away from its seat until tool contacts upper surface of valve guide.

Position dial indicator with its flat tip against center portion of tool's spherical section at approximately 90 degrees to valve stem axis. Move tool back and forth in line with indicator stem. Take a reading on dial indicator without removing tool from valve guide upper surface. Divide reading by two, the division factor for tool. If valve stem to valve guide clearance exceeds specifications, install new valve guide as outlined.

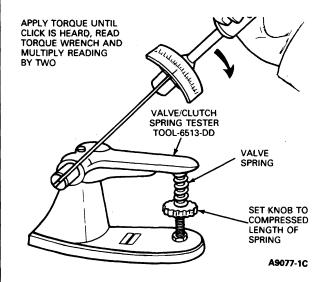
#### Check Valve Stem Clearance — Typical



#### **Valve Spring Pressure**

Check the valve spring for proper pressure at specified spring lengths using Valve / Clutch Spring Tester TOOL-6513-DD or equivalent. Weak valve springs cause poor performance; if pressure of any spring is lower than service limit, replace spring.

#### **Checking Valve Spring Pressure**

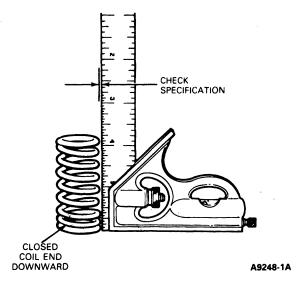


#### Valve Spring Squareness

Check each spring for squareness using a steel square and a surface plate. Stand spring and square on end on surface plate. Slide spring up to square. Rotate spring slowly and observe space between top coil of spring and square. If spring is out of square more than 1.984mm (5/64 inch), replace it.

Follow same procedure to check new valve springs before installation.

# **Checking Valve Spring Squareness**



#### **Intake Manifold**

#### Cleaning

Remove all gasket material from machined surfaces of manifold. Clean manifold in a suitable solvent and dry with compressed air.

#### Inspection

Inspect manifold for cracks, nicked gasket surfaces, or other damage that would make it unfit for further service. Place cylinder head mounting faces of manifold on a smooth, clean surface and check for warpage. Replace manifold if warped or cracked.

#### **Exhaust Manifolds**

#### Cleaning

Remove all gasket material from manifold(s).

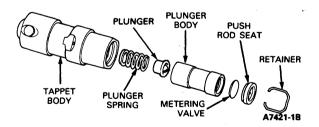
#### Inspection

Inspect manifold(s) for cracks, damaged gasket surfaces, or other wear or damage that would make them unfit for further service. Inspect cylinder head joining flanges of exhaust manifold(s) for evidence or warpage by placing on a flat surface. Minor warpage can be corrected by surface grinding. If warpage is extreme, replace manifold.

# **Hydraulic Valve Tappets**

Valve tappet assemblies should be kept in proper sequence to permit installation into original position. Inspect and test each tappet separately to prevent intermixture of internal parts. If any part of tappet assembly needs replacing, replace the entire assembly.

#### **Tappet Assembly**



#### Disassembly

- 1. Remove plunger retainer with small screwdriver.
- 2. Remove push rod seat and metering valve.
- 3. Remove plunger and plunger spring.

#### Cleaning

Thoroughly clean all parts in clean solvent and wipe with a clean, lint-free cloth.

#### Inspection

Inspect parts and discard the entire tappet assembly if any part shows pitting, scoring, galling or evidence of non-rotation. Replace entire assembly if the plunger is not free in body. Plunger should drop to bottom of body by its own weight when assembled dry.

Roller should rotate freely, without excessive play. Check for missing or broken needle bearings. Roller should be free of pits or roughness. If present, inspect camshaft lobes for similar condition. If pits or roughness are evident, replace cam follower and camshaft.

#### **Assembly**

- 1. Coat all parts with specified engine oil.
- Install plunger spring and plunger into tappet body.
- Install metering valve and push rod seat into tappet body and install retaining ring.

Check for free operation by pressing down on the push rod cup. Tappets can also be checked with a hydraulic tester to test leak-down rate. Follow instructions provided with test unit.

#### Camshaft

Clean camshaft in solvent and wipe dry. Inspect camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in general area of lobe toe. This pitting is not harmful to the operation of camshaft; therefore, camshaft should not be replaced unless camshaft lobe lift loss has exceeded specifications.

Check camshaft lobe lift with camshaft installed in engine or on centers. Refer to Camshaft Lobe Lift under Diagnosis and Testing.

Check fuel pump eccentric for excessive wear.

#### **Drive Gears**

#### Cleaning

Clean gears in solvent and dry with compressed air.

#### Inspection

Inspect gear teeth for scores, nicks, etc. Note condition of tooth contact pattern. If teeth are scored, replace gears.

It is not necessary to replace gears in sets. Replace damaged gears and check backlash, runout, etc, as described in this section, to determine if any other gear should be replaced.

# **Crankshaft Vibration Damper**

#### Cleaning

Clean oil seal contact surface on crankshaft damper sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits not readily removable with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage oil seal during installation or cause premature seal wear. Do not use crocus cloth to the extent that seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.

# Inspection

Inspect crankshaft vibration damper sleeve oil seal surface for nicks, sharp edges or burrs that might damage oil seal during installation.

#### Crankshaft

#### Cleaning

Handle crankshaft with care to avoid possible fractures or damage to finish surfaces. Clean crankshaft with solvent, and blow out all oil passages with compressed air.

Clean oil seal contact surface at rear of crankshaft with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits not readily removable with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage oil seal during installation or cause premature seal wear. Do not use crocus cloth to the extent that seal surfaces become polished. A finely polished surface may produce poor sealing or cause premature seal wear.

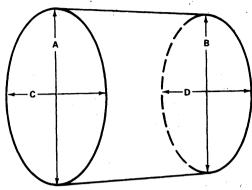
#### Inspection

Inspect main and connecting rod journals for cracks, scratches, grooves or scores.

Measure diameter of each journal at least four places to determine out-of-round, taper or undersize condition.

#### **Crankshaft Journal Measurement**

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

A10094-1A

Bearing failures can cause overheating of crankshaft journals and a reduction of hardness. When this occurs, the crankshaft strength may be unacceptably reduced. Whenever bluing is found on the journal or fillet area, the crankshaft must be replaced.

Crankshafts must not be straightened. Even slight straightening with complete absence of cracks will endanger the high strength built into the shaft.

#### **Flywheel**

#### **Automatic Transmission**

#### Inspection

Inspect flywheel for cracks or other damage that would make it unfit for further service. Inspect starter ring gear for worn, chipped or cracked teeth. If teeth are damaged, replace ring gear.

With flywheel installed on crankshaft, check gear face runout of flywheel (refer to Diagnosis and Testing in this section).

#### **Flywheel**

#### **Manual-Shift Transmission**

#### Inspection

Inspect flywheel for cracks, heat checks, or other damage that would make it unfit for further service. Machine friction surface of flywheel if it is scored or worn. If it is necessary to remove more than 1.016mm (0.040 inch) of stock from original thickness, or if flywheel thickness is less than 14mm (0.55 inch) after refacing, replace secondary flywheel. If necessary, refer to Secondary Flywheel Removal and Installation.

CAUTION: Installation of a flywheel less than 14mm (0.55 inch) thick can cause primary flywheel damage.

Inspect ring gear for worn, chipped, or cracked teeth. If teeth are damaged, replace ring gear.

With flywheel installed on crankshaft, check flywheel face runout, following procedure described under Diagnosis and Testing.

#### Main and Connecting Rod Bearing

CAUTION: In event of bearing failure, the oil cooler must be disassembled and the tube bundle must be replaced.

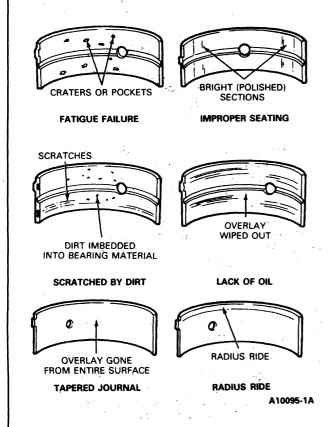
#### Cleaning

Clean bearing inserts and caps thoroughly in solvent, and dry with compressed air. Do not scrape gum or varnish deposits from bearing shells.

#### Inspection

Inspect each bearing carefully. Bearings with scored, chipped, or worn surface should be replaced. Typical examples of bearing failure and causes are shown. Cooper-lead bearing base may be visible through bearing overlay in small localized areas. This may not mean that bearing is excessively worn. It is not necessary to replace the bearing if bearing clearance is within recommended limits. Check clearance of bearings that appear to be satisfactory with Plastigage D81L-6002-B, or equivalent. Fit new bearings as outlined.

# **Typical Bearing Failures**



# **Connecting Rods**

#### Cleaning

Remove bearings from rod and cap. If bearings are to be reused, mark them to facilitate their installation into original positions. Clean connecting rod in solvent, including rod bore and back of inserts. **Do not use a caustic cleaning solution.** 

# Inspection

Connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on edge of piston pin bushing usually indicates that a connecting rod is bent or piston pin hole is not in proper relation to piston skirt and ring grooves.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, an improperly machined journal, or a tapered connecting rod bore.

Twisted connecting rods will not create an easily identifiable wear pattern, but badly twisted rods will disturb action of entire piston; rings, and connecting rod assembly, and may be cause of excessive oil consumption.

Inspect connecting rods for signs of fractures. Inspect bearing bores for out-of-round and taper. If bore exceeds maximum limit and/or if rod is fractured, replace rod.

Check ID of connecting rod piston pin bushing. If pin bore is not within specification, replace rod. Replace worn or damaged connecting rod nuts and bolts.

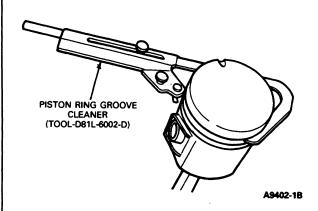
After connecting rods are assembled to piston, check rods for bends or twists on a suitable alignment fixture. Follow instructions of fixture manufacturer. If bend and/or twist exceeds specifications, replace rod.

# Pistons, Pins and Rings

Remove deposits from piston surfaces. Clean gum or varnish from piston skirt, piston pins and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.** Clean ring groove with a Piston Ring Groove Cleaner D81L-6002-D or equivalent.

CAUTION: Extreme care must be used when cleaning grooves on aluminum pistons.

# Cleaning Ring Grooves — Typical

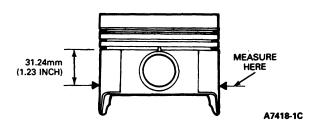


#### Inspection

Carefully inspect pistons for fractures at ring lands, skirts, and pin bosses. Inspect pistons for scuffed, rough, or scored skirts. If lower inner portion of ring grooves have high steps, replace piston. The step will interfere with ring operation and cause excessive ring side clearance. Replace pistons that show signs of excessive wear, wavy ring lands, or fractures.

Check piston-to-cylinder bore clearance by measuring piston and bore diameter. Refer to Cylinder Block Inspection for bore measurement procedure. Measure OD of piston with a micrometer at top of piston skirt and at 90 degrees to pin bore axis. Check ring side clearance following procedure described under Fitting Piston Rings.

#### **Piston Diameter**



Replace piston pins showing signs of fracture, etching, or wear. Check piston pin fit in piston and rod. Refer to Piston, Pins and Rings.

Replace all rings that are scored, chipped or cracked. Check ring end gap and side clearance. It is good practice to always install new rings when overhauling an engine. Rings should not be transferred from one piston to another, regardless of mileage.

# **Cylinder Block**

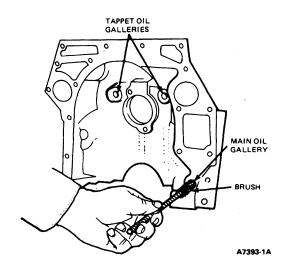
#### Cleaning

After any cylinder bore repair operation, such as honing or deglazing, clean bore(s) with soap and water. Thoroughly rinse bore(s) with clean water to remove soap, and wipe bore(s) dry with a clean, lint-free cloth. Wipe bore(s) with a clean cloth dipped in engine oil. If these procedures are not followed, rusting of cylinder bore(s) may occur.

If engine is disassembled, thoroughly clean block in solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs sealing oil passages. Thoroughly clean all passages. Blow out all passages, bolt holes, etc., with compressed air.

Remove main oil gallery plug and use a 9.5mm (3/8-inch) diameter brush to clean main oil gallery. Replace oil plug after coating with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A), or equivalent, non-hardening sealing compound.

#### Cleaning Main and Tappet Oil Galleries with Brush



Remove tappet oil gallery plugs by drilling small hole in plug and prying with a screwdriver or suitable tool. Clean tappet oil galleries with a 8mm (5 / 16-inch) brush. Replace tappet gallery plugs flush to 1.52mm (.060-inch) below crankcase surface as outlined.

Ensure threads in cylinder head bolt holes are clean. Dirt in threads may cause binding and result in false torque readings. Use tap to true-up threads and to remove any deposits.

#### Inspection

After block has been thoroughly cleaned, check it for cracks. Minute cracks not visible to the naked eye may be detected by coating suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. Avoid use of methanol substitute rubbing alcohol. If cracks are present, coating will become discolored at cracked area. Replace block if cracked.

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone. Check cylinder block for flatness of cylinder head gasket surface following procedure and specifications recommended for cylinder head.

NOTE: If flatness is out of specification, do not resurface top deck of crankcase. Replace cylinder block.

Replace all expansion-type plugs showing evidence of leakage.

Inspect cylinder walls for scoring, roughness, or other signs of wear. Check cylinder bore for out-of-round and taper. Measure bore with an accurate bore gauge following instructions of manufacturer. Measure diameter of each cylinder bore at top, middle and bottom with gauge placed at right angles and parallel to centerline of engine. Use only measurements obtained at 90 degrees to engine centerline when calculating piston-to-cylinder bore clearance.

Refinish cylinders that are deeply scored and/or when out-of-round and/or taper exceed specifications.

If cylinder walls have minor surface damage, but out-of-round and taper are within limits, it may be possible to remove such damage by honing cylinder walls and installing new service piston rings, providing piston clearance is within specified limits.

To remove cylinder wall glaze or to refinish a cylinder bore, follow deglazing and honing procedures described under Cylinder Block-Refinishing Cylinder Walls.

#### Oil Pan

#### Cleaning

Scrape any dirt or metal particles from inside of pan. Scrape or wire brush all old gasket material from gasket surface. Wash pan in a degreasing solvent and dry it thoroughly. Ensure all foreign particles are removed from below baffle plate.

#### Inspection

Check pan for cracks, holes and damaged drain plug threads. Check gasket surface for damage caused by over-tightened bolts. Straighten surface as required to restore original flatness.

Replace pan if repairs cannot be made.

#### **Oil Pump**

Check oil pump drive gear backlash as outlined. If backlash is out of specification, replace pump. Oil pump is serviced as a complete assembly only.

#### Oil Cooler

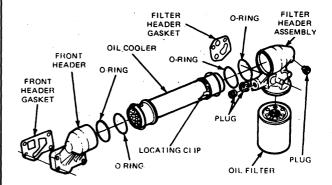
If oil is found in the cooling system, or coolant found in the oil, the oil cooler should be checked for leakage as outlined.

If oil cooler O-rings are leaking, remove oil cooler as outlined. Disassemble and repair as follows.

#### Disassembly

- Gently rap front and oil filter headers to loosen O-rings. Twist oil cooler apart.
- Thoroughly clean oil cooler, front header, and filter header in suitable solvent. The oil cooler should be thoroughly flushed and drained to remove all residue within it.
- Use new O-rings when assembling oil cooler. Lubricate all O-ring mating surfaces and O-rings prior to assembly with clean engine oil.

#### Oil Cooler



A7422-1B

#### Assembly

- Install one rust colored O-ring into each header.
   NOTE: Install the large O-ring on the oil cooler bundle first, then install the small O-ring on the oil bundle.
- 2. Place large O-ring over oil cooler shell.
- 3. Press assembly together ensuring locating clips align in slots.
- Test oil cooler assembly, as outlined before installing on engine.

#### **Mechanical Fuel Supply Pump**

Inspect fuel supply pump for cracks or damage. Inspect mounting flange for distortion. Inspect rocker arm spring, pin and rocker arm for wear, cracks or damage. If any fuel supply pump components are damaged, replace fuel supply pump.

#### **Thermostat**

To check operation, place thermostat in a pan of water, heat water, and using an accurate thermometer, observe water temperature when thermostat starts to open. Thermostat should start to open at approximately 100-107°C (180-192°F) and be fully open at approximately 111-118°C (200-212°F). The thermostat is not adjustable. If it does not operate within above limits, replace it.

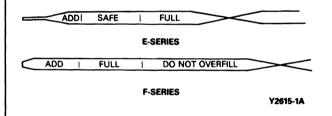
If problem being investigated is insufficient heat, thermostat should be checked for leakage. This may be done by holding thermostat up to a lighted background. Light leakage around thermostat valve (thermostat at room temperature) is unacceptable, and thermostat should be replaced.

# **MAINTENANCE**

#### **Engine Oil Level**

Check crankcase oil level each time you stop for fuel. Keep the oil level between the FULL and ADD marks on the dipstick. The distance between the ADD and FULL marks on the diesel engine represents two quarts. DO NOT OVERFILL.

#### 7.3L Diesel Oil Level Indicators



#### **Engine Fuel Filter**

Refer to Owner's and Operator's Guide or Section 10-02. Maintenance.

#### **Engine Idle Speed**

Refer to the Engine / Emissions Diagnosis\* Manual for procedures and specifications.

#### **Accelerator Linkage**

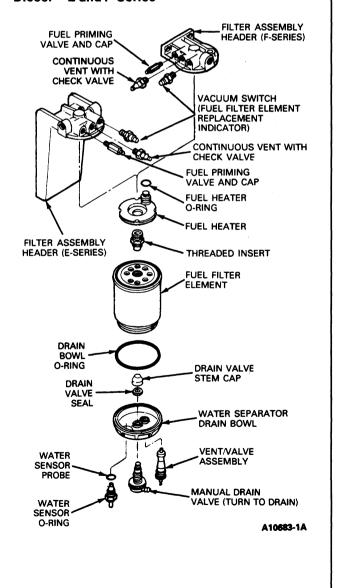
Check accelerator linkage for sticking or binding. Ensure that throttle lever returns to the idle stop on the injection pump. Service or adjust, as necessary. Lubricate friction points as specified in Section 10-02, Maintenance.

# Fuel Filter/Fuel Heater/Water Separator

The 7.3L diesel engine is equipped with a fuel filter / fuel heater / water separator assembly. A WATER IN FUEL indicator lamp is provided on the instrument panel to alert the operator. The lamp should glow when the ignition switch is in the ON position to indicate proper lamp and water sensor function. If the lamp glows continuously while the engine is running, the water must be drained from the fuel filter / fuel heater / water separator manual drain valve as soon as practical to prevent damage to the fuel injection system.

Drain water from the fuel filter / fuel heater / water separator manual drain valve whenever the warning lamp comes on or every 8,046 km (5,000 miles). The WATER IN FUEL lamp will glow when approximately 103 ml (3.5 fluid ounces) of water accumulates in separator.

# Fuel Filter/Fuel Heater Water Separator — 7.3L Diesel — E and F-Series



\*Can be purchased as a separate item.

# **MAINTENANCE** (Continued)

#### Drain Procedure—(E and F-Series)

- 1. Stop vehicle and shut off engine.
  - NOTE: To avoid engine stall-out caused by air entering the fuel system, do not drain fuel/water separator while engine is running.
- Place an appropriate container under the fuel filter/fuel heater/water separator drain tube to collect drain fluid. The drain tube is attached to the manual drain valve at base of water separator drain bowl.
- Manually open drain valve by unscrewing. Allow drain valve to remain open approximately 15 seconds or until clear (water-free) diesel fuel flows from drain tube. Close drain valve by threading into water separator drain bowl until liquid no longer drains from drain tube.

# WARNING: ENSURE THAT DRAIN VALVE IS FULLY AND SECURELY CLOSED.

 Re-start the engine and check WATER IN FUEL lamp. The lamp should not glow. If it continues to glow, have fuel system checked and repaired.

Drain all traces of water from the fuel filter/fuel heater/water separator as outlined at 8,046 km (5,000 mile) intervals as specified in the maintenance schedule. At this service interval, if the warning lamp is not glowing, examine the draining fluid to determine when clear diesel fuel flows from the drain tube. Stop draining procedure as soon as clear diesel fuel appears.

# **SPECIFICATIONS**

#### **GENERAL SPECIFICATIONS**

| Engine                | Bore and Stroke         | Firing Order    | Oil Pressure<br>Hot @ 3300 RPM<br>kPa (PSI) | Engine Type<br>and Number of<br>Cylinders | Compression<br>Ratio |
|-----------------------|-------------------------|-----------------|---|---|----------------------|
| 7.3L Diesel (444 CID) | 4.1095 in. x 4.1120 in. | 1-2-7-3-4-5-6-8 | 276-482 kPa (40-70)                         | O.H.V. V-8                                | 21.5 to 1            |

|           | Newly Inc | stalled ① | Used Ove | er 10 Min. |
|-----------|-----------|-----------|----------|------------|
| Belt Size | Kg        | (ibs)     | Kg       | (lbs)      |
| All       | 55-72     | 120-160   | 34-54    | 75-120②    |

Tension measured immediately after belt is installed and before it is stretched or seats in pulley grooves (all belts).

#### CYLINDER HEAD

| Engine          | Pre-Chamber<br>Insert<br>Protrusion |                          | Guide<br>ore<br>neter<br>Exhaust | Valve<br>Wick<br>Intake                  | Seat<br>h 1)<br>Exhaust                  | Valve Seat<br>Runout TIR<br>Maximum | Valve Arrangement Front to Rear | Gasket<br>Surface<br>Flatness<br>2                             |
|-----------------|-------------------------------------|--------------------------|----------------------------------|--|--|-------------------------------------|---------------------------------|--|
| 7.3L Diesel V-8 | -0.0025 in.<br>+ 0.0025 in.         | 0.3736 in.<br>0.3746 in. | 0.3736 in.                       | 0.065"-<br>0.095"<br>(1.651-<br>2.413mm) | 0.065"-<br>0.095"<br>(1.651-<br>2.413mm) | 0.002 in.<br>(0.05mm)               |                                 | 0.003" (0.0762mm) in any 6<br>in.<br>0.006" (0.1524mm) overall |

①Valve seat angle — intake 30° and Exhaust 37.5°.

#### VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

|                 |                              |                                | 1  | /alve Tappet o                                 | r Lifter                            |  |
|-----------------|------------------------------|--------------------------------|--|--|-------------------------------------|--|
| Engine          | Туре                         | Push Rod Runout<br>TIR Maximum | Standard<br>Diameter                             | Clearance to Bore 1                            | Hydraulic Lifter<br>Leakdown Rate 2 | Collapsed Tappet Gap<br>(Clearance)(3) |
| 7.3L Diesel V-8 | Hydraulic Roller<br>Follower | 0.015 in.                      | 0.9209 in<br>0.9217 in.<br>(23.391-<br>23.411mm) | 0.0011 in<br>0.0034 in.<br>(0.027-<br>0.086mm) | 20-110 Sec.<br>For 0.125" Travel    | 0.185 Max.                             |

①Service Limit — .005.

# VALVE SPRINGS

|                 | Compression | Valve Spring<br>Compression Pressure<br>Lbs. @ Specified Height |                                       | Spring<br>Length<br>ximate)           | Vaive Spring<br>Assembled<br>Height |         | Valve Spring Out of Square |
|-----------------|-------------|---|---------------------------------------|---------------------------------------|-------------------------------------|---------|----------------------------|
| Engine          | Intake(1)   | Exhaust   | Intake                                | Exhaust                               | Intake                              | Exhaust | Maximum                    |
|                 |             |   | 2.075 in.<br>± 0.150 in.<br>(52.705mm | 2.075 in.<br>± 0.150 in.<br>(52.705mm |                                     |         |                            |
| 7.3L Diesel V-8 | 80 @ 1.83   | 80 @ 1.833  | ± 3.8mm)                              | ± 3.8mm)                              | 1.767                               | 1.833   | 5/64 (0.078)               |

①Service Limit — 10% loss of pressure.

#### VALVES

|                 | Valve Stem to Gu     | uide Clearance()     | Valve Fa | Valve Face Runout |                       |
|-----------------|----------------------|----------------------|----------|-------------------|-----------------------|
| Engine          | intake               | Exhaust              | Intake   | Exhaust           | TIR Maximum           |
| 7.3L Diesel V-8 | 0.0055 in. (0.140mm) | 0.0055 in. (0.140mm) | 30°      | 37.5°             | 0.0015 in. (0.0381mm) |

Service clearance — .0055.

#### **VALVES (Continued)**

| Engine          | Minimum Value Face<br>Margin-Intake Valves | Minimum Value Face Margin —<br>Exhaust Valves |
|-----------------|--|---|
| 7.3L Diesel V-8 | 0.112 inch (2.84mm)                        | 0.053 inch (1.35mm)                           |

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<sup>(2)</sup> If less than 34 Kg (75 lbs), readjust to 41-54 Kg (90-120 lbs).

②Gasket surface finish — RMS 60-150.

②Time required for plunger to leakdown .125 in. under load of 50 lbs. using leakdown fluid in tappet. ③Measured at valve tip to rocker arm.

#### **VALVES (Continued)**

|             | Valve Sten       | n Diameter  | Valve Head Recession Relative To Deck Surface |                           |  |  |
|-------------|------------------|-------------|---|---------------------------|--|--|
| Engine      | . Intake Exhaust |             | Intake  | Exhaust                   |  |  |
| 7.3L Diesel | .3716537235      | .3716537235 | .042054 in.(1.06-1.37mm)                      | .051063 in. (1.29-1.60mm) |  |  |

#### CAMSHAFT

|             | Camshaft               | End Play |                                       |
|-------------|------------------------|----------|---------------------------------------|
| Engine      | End Play Service Limit |          | Camshaft Journal to Bearing Clearance |
| 7.3L Diesel | .002009 inch           |          |                                       |
|             | (.025228mm)            | _        | 0.0381-0.0889mm (0.0015-0.0035 in.)   |

#### **CAMSHAFT DRIVE**

|                 |   | Camshaft I                                    | Bearing Inside                                | Camshaft Front Bearing                        |   |                   |                    |
|-----------------|---|---|---|---|---|-------------------|--------------------|
| Engine          | No. 1   | No. 2   | No. 3   | No. 4   | No. 5   | Location 1        | Gear Backlash      |
| 7.3L Diesel V-8 | 2.1015-<br>2.1025 inch<br>(53.37-<br>53.40mm) | 0.020-0.050 inch) | 0.0015-0.013 inch) |

①Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

#### INJECTION PUMP DRIVE GEAR BACKLASH - 0.0055-0.0010

#### CYLINDER BLOCK

| Engine      | Cylinder Bore Diameter (1) 3            | Main Bearing Inside Dlameter ②       | Head Gasket Surface<br>Flatness               | Head Gasket Surface<br>Finish |       | Oversize                    |
|-------------|---|--------------------------------------|---|-------------------------------|-------|-----------------------------|
|             |   |                                      |   |                               | 0.010 | 4.11425 inch<br>(104.502mm) |
| 7.3L Diesel | 4.1095-4.1115 inch<br>(104.38-104.43mm) | 3.3152-3.3162 in.<br>(84.21-84.23mm) | 0.003 inch in any 6 in.<br>0.006 inch overall | RMS 63-125                    | 0.020 | 4.12425 inch<br>(104.756mm) |
|             |   |                                      |   |                               | 0.030 | 4.13425 inch<br>(105.010mm) |

# CRANKSHAFT AND FLYWHEEL

| Engine      |       | Main Bearing<br>Journal<br>Diameter 1 | Main Bearing<br>Journal Runout<br>TIR Maximum② | Main Bearing<br>Thrust Face<br>Runout TIR<br>Maximum | Main Bearing<br>Journal Taper<br>Maximum Per<br>Inch | Thrust Bearing<br>Journal Length |      | Main Bearing<br>Thrust Face<br>Finish RMS<br>Maximum |
|-------------|-------|---------------------------------------|--|--|--|----------------------------------|------|--|
| 7.3L Diesel |       | 3.1228-3.1236                         | 0.002 inch                                     | 0.001 inch   | 0.0005 inch  | 1.1325-1.1355<br>inch            | 5-20 | 5-20   |
|             | 0.010 | 3.1128-3.1136 in                      |  |  |  | •                                |      |  |
| Undersize   | 0.020 | 3.1028-3.1036 in.                     |  |  |  | ]                                |      |  |
|             | 0.030 | 3.0928-3.0936 in.                     |  |  |  | :                                |      |  |

①Maximum out-of-round — 0.0002.

#### **CRANKSHAFT FLYWHEEL (Continued)**

| Engine      |       | Connecting Rod Journal Diameter ① | Connecting Rod Journal Taper<br>Per Inch Maximum | Crankshaft End Play ② | Flywheel and Ring<br>Gear Runout |
|-------------|-------|-----------------------------------|--|-----------------------|----------------------------------|
| 7.3L Diesel |       | 2.4980-2.4990 in.                 | 0.0005 in.                                       | 0.0025-0.0085 in.     | 0.030 in.                        |
|             | 0.010 | 2.488-2.489 in                    |  |                       | Flywheel and                     |
| Undersize   | 0.020 | 2.478-2.479 in.                   |  |                       | Ring Gear<br>Concentricity       |
|             | 0.030 | 2.468-2.469 in.                   | 1  |                       | 0.020 in.                        |

①Maximum out-of-round — .0003.

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②All camshaft journals are 2.0990-2.1000.

Maximum out-of-round — .002; Maximum taper — 0.002 inch; Cylinder bore surface finish RMS 15-30.
 With bearing caps tightened in place.
 Note: Bore diameter of cylinders 1-6 — 4.1095 in. to 4.1115 in. Bore diameter of cylinders 7 and 8 only — 4.1100-4.1120 in.

Service limit — 0.005.

<sup>2</sup> Service limit - .012.

#### **CRANKSHAFT BEARINGS**

|             | Connecting Rod Bearing to Crankshaft Clearance<br>Selective Fit |                   |                                | Main Be           | áring to Crankshaft C<br>Selective Fit | learance                       |
|-------------|---|-------------------|--------------------------------|-------------------|--|--------------------------------|
| Engine      | Desired   | Allowable         | Bearing Wall<br>Thickness Std. | Desired           | Allowable                              | Bearing Wall<br>Thickness Std. |
| 7.3L Diesel | 0.0011-0.0036 in.   | 0.0011-0.0036 in. | _                              | 0.0018-0.0036 in. | 0.0018-0.0046 in.                      |                                |

#### **CONNECTING ROD**

| ·           | Piston Pin        | Rod Bearing       | Rod Length       |           | od Alignment<br>tal Difference | Rod to Crankshaft |
|-------------|-------------------|-------------------|------------------|-----------|--------------------------------|-------------------|
| Engine      | . Bushing I.D.    | I.D.① ③           | Center to Center | Twist2    | Bend ②                         | Side Clearance    |
| 7.3L Diesel | 1.1105-1.1108 in. | 2.5001-2.5016 in. | 7.128-7.132 in.  | 0.002 in. | 0.002 in.                      | 0.012-0.024 in.   |

①Connecting rod bearing bore maximum out-of-round — .0005 and maximum bore taper — .0005.

With bearing caps tightened in place.

#### **PISTON**

| Engine      | Skirt Diameter ① '② Standard | Piston to Bore Clearance Selective Fit② | Piston Pin Bore Diameter | Piston Height<br>Above Crankcase | Ove       | ersize           |
|-------------|------------------------------|---|--------------------------|----------------------------------|-----------|------------------|
|             |                              |   |                          |                                  | 0.010 in. | 4.11425 in.<br>④ |
| 7.3L Diesel | 4.10375 in. ± 0.00025 in.    | See Note Below                          | 1.1104-1.1106            | 0.010-0.031                      | 0.020     | 4.12425 in.      |
|             |                              |   |                          |                                  | 0.003     | 4.13425 in.      |

①Measured at 90 degrees to the pin, at 1.25 inch below oil ring groove.

②Service piston is 4.10375 in.  $\pm$  0.00025 in.

### PISTON PIN

|   | Engine      | Length          | Diameter          | Ring End Clearance | To Piston Pin<br>Bore Clearance (1) | To Connecting Rod<br>Bushing Clearance |
|---|-------------|-----------------|-------------------|--------------------|-------------------------------------|--|
| L | 7.3L Diesel | 2.692-2.702 in. | 1.1099-1.1101 in. | 0.001-0.029 in.    | 0.0003-0.0007 in.                   | 0.0004—0.0009 in.                      |

①Selective fit.

#### **PISTON RINGS**

|             |                     | Side Clearance 1          |                 | )           | Ring Gap           |                     |     |           |           |
|-------------|---------------------|---------------------------|-----------------|-------------|--------------------|---------------------|-----|-----------|-----------|
|             | Standard            | Compr                     | ression         |             | Compr              | ession              |     | 1         |           |
| Engine      | Ring Diameters      | Тор                       | Bottom          | Oil         | Тор                | Second              | Oil | Over      | size      |
|             | 4.11 in. (104.39mm) | 0.002-0.004 in. 0.002-0.0 |                 | 0.001-0.003 | 03 0.013-0.045 in. | in. 0.060-0.085 in. |     | 0.010 in. | 4.120 in. |
| 7.3L Diesel |                     |                           | 0.002-0.004 in. |             |                    |                     |     | 0.020 in. | 4.130 in. |
|             |                     |                           | <u>L</u>        | ""          |                    |                     |     | 0.030 in. | 4.140 in. |

<sup>(1)</sup> Service limit — .002 maximum increase in clearance.

#### OIL PUMP, OIL COOLER AND OIL CAPACITY

|             | Oil Pump Pressures |             | Engine Oil Capacity① |               |        |                              |  |
|-------------|--------------------|-------------|----------------------|---------------|--------|------------------------------|--|
| Engine      | 700 RPM            | 3300 RPM    | U.S. Qts.            | Imperial Qts. | Liters | Oil Pump Drive Gear Backlash |  |
|             |                    | 276-482 kPa |                      |               |        |                              |  |
| 7.3L Diesel | 69 kPa (10 psi)    | (40-70 psi) | 9                    | 9.7           | 8.5    | 0.0056-0.010 in.             |  |

①Add 1 U.S. quart (or equivalent in Imperial quarts or liters) when replacing filter.

#### OIL SEALS

| Crankcase Oil Seal Journal Finish         | 10-20 RMS |
|---|-----------|
| Front Oil Seal Journal Finish (On Damper) | 10-20 RMS |

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②Pin bushing and crankshaft bore must be parallel and in same vertical plane within specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

Clearance in cylinder bores 1-6 only: 0.0055-0.0085 inch.
 Clearance in cylinder bores 7 and 8 only: 0.0060-0.0085 inch.
 Oversize service piston specifications are all ± 0.0005 inch.

#### SPECIAL TORQUE WRENCH INFORMATION

Use of special tool torquing adapters requires use of calculations from the formula below.

- T = Desire torque from specifications tables
  L = Length of torque wrench in inches/MM
- E = Length of adapter in inches/MM
- Y = Indicated torque wrench setting/reading

$$Y = \frac{T \times L}{L + E}$$

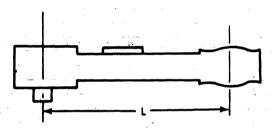
Example: Desired torque from specifications (T) is 100 lb. ft.

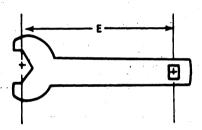
Adapter is 8" Long (E) Torque wrench is 15" Long (L)

$$Y = \frac{100 \times 15}{15 + 8}$$

$$Y = \frac{1500}{23}$$

Y = 65 (Approx.)





Note: Units for L or E may be either metric or inches — but same units must be used for both.

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#### TORQUE LIMITS - 7.3L V-8 DIESEL ENGINE

NOTE: Unless otherwise specified, use standard torque chart. Torque values are with threads and washer faces coated with engine oil. Torque values are listed without tolerance. Variations to torque will occur due to torque wrench calibration. Variation should be within 10% of nominal values.

#### STANDARD TORQUE

| 1/4x20 UNC        | 5/16-18 UNC       | 3/8-16 UNC        | 7/16-14 UNC       | 1/2x13 UNC        |
|-------------------|-------------------|-------------------|-------------------|-------------------|
| 9.5 N·m (7 ft-lb) | 19 N-m (14 ft-lb) | 32 N-m (24 ft-lb) | 51 N-m (38 ft-lb) | 81 N•m (60 ft-lb) |

#### PIPE THREADS

| 1/8x27               | 1/4x18                  | 3/8x18                  | 1/2x14                  |
|----------------------|-------------------------|-------------------------|-------------------------|
| 7-11 N•m (5-8 ft-lb) | 17-24 Nem (12-18 ft-lb) | 30-44 N-m (22-33 ft-lb) | 34-47 N-m (25-35 ft-lb) |

| Item  | N•m                  | See Note                        | Ft-Lb               |
|---|----------------------|---------------------------------|---------------------|
| Air Cleaner Stud Adapter 61 Nem (45 ft-lb.) (See Note (9) |                      |                                 |                     |
| Camshaft Gear Screw                                       | 20                   |                                 | 15                  |
| Connecting Rod Nut  |                      | 2                               |                     |
| Crankcase Front Cover                                     |                      | 0                               |                     |
| Cylinder Head Bolts (New)                                 |                      | 3                               |                     |
| Damper to Crankshaft                                      | 122                  |                                 | 90                  |
| CDR Valve   |                      | 0                               |                     |
| Fan Clutch to Water Pump (LH Thread)                      | 61                   |                                 | 163                 |
| Fuel Supply Pump  |                      | 1                               | <del></del>         |
| Fuel Filter Adapter to Bracket                            | 33-52                |                                 | 24-39               |
| Fuel Filter Bracket to Cylinder Block                     | 33-52                |                                 | 24-39               |
| Fuel Filter to Adapter                                    | 1/2 turn             | n after gasket contacts sealing | surface             |
| Flywheel to Crankshaft                                    | 64                   | <b>9</b>                        | 47                  |
| Main Bearing Cap Bolts                                    |                      | <u> </u>                        |                     |
| Manifold — Exhaust (with Prevailing Torque Bolt)          | 47                   | •                               | 35                  |
| Manifold — Intake   | 33                   | 6                               | 24                  |
| Oil Filter to Header Adapter                              | 1-1/4 to 2 turns aft | er gasket contacts sealing sui  | face - oiled gasket |
| Oil Cooler to Cylinder Block                              |                      | $\bigcirc$                      |                     |
| Oil Cooler Plug   | 21                   |                                 | 15                  |
| Oil Pan Drain Plug  | 37                   |                                 | 28                  |
| Oil Pan to Cylinder Block                                 |                      | 0                               |                     |
| Pulley to Vibration Damper                                |                      | 0                               |                     |
| Secondary Flywheel to Primary Flywheel                    | 64                   | 1                               | 47                  |
| Valve Cover Bolt  | 8                    | <b>②</b>                        | 6                   |
| Valve Lever Post Bolt                                     | 27                   | † – – – †                       | 20                  |
| Glow Plug   | 16                   | <del> </del>                    | 12                  |
| Nozzle Assembly   | 47                   |                                 | 35                  |
| Nozzle Connector Nut (Injection Pipe)                     | 30                   | <del> </del>                    | 22                  |
| Injection Pump Outlet Fitting Nut                         | 30                   |                                 | 22                  |
| Injection Pump Gear Cover                                 | 19                   | 9                               | 14                  |
| Injection Pump Gear Mounting Bolts                        | 34                   | T                               | 25                  |
| Water Pump to Front Cover                                 | 19                   | <b>3</b>                        | 14                  |
| Heater Hose Connector (Water Pump, Cylinder Head)         | 17-24                | †                               | 12-18               |
| Alternator Bracket to Cylinder Block                      | 33-52                |                                 | 24-39               |
| Alternator Pivot Bolt                                     | 38-71                |                                 | 28-53               |
| Alternator Support Bracket to Water Pump                  | 33-52                |                                 | 24-39               |
| Alternator Adjusting Arm to Support                       | 33-52                |                                 | 24-39               |
| Alternator Adjusting Bolt                                 | 33-52                |                                 | 24-39               |
| Water Outlet (Thermostat)                                 | 27                   |                                 | 20                  |

Use Standard Torque Chart Above.
 Tighten to 51 N+m (38 ft-lb), then to 69 N+m (51 ft-lb).
 Tighten to 51 N+m (65 ft-lb), then to 122 N+m (90 ft-lb), then 135 N+m (110 ft-lb).
 Tighten to 101 N+m (75 ft-lb), then to 129 N+m (95 ft-lb).
 Tighten to 101 N+m (75 ft-lb), then to 129 N+m (95 ft-lb).
 Tighten to 101 N+m (75 ft-lb), then to 129 N+m (95 ft-lb).
 Tighten to 33 N+m (24 ft-lb), then tighten again in sequence.
 Tighten to 8 N+m (6 ft-lb), then tighten again to 8 N+m (6 ft-lb) in sequence.
 Tighten to 47 N+m (35 ft-lb), then tighten again to 47 N+m (35 ft-lb) in sequence. Apply anti-seize compound prior to installation.
 Apply Lock'n Seal® to all threads prior to assembly.

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# SPECIAL SERVICE TOOLS

| Tool Number    | Description                     | Tool Number  | Description                             |
|----------------|---------------------------------|--------------|---|
| T50T-100-A     | Impact Slide Hammer             | D83T-6084-A  | Exhaust Valve Seat Remover/Replacer     |
| T59L-100-B     | Impact Slide Hammer             | D83T-6134-B  | Cooling Jet Tube Target                 |
| D82L-800-B     | Hammer                          | D83T-6136-A  | Connecting Rod Installation Guides      |
| T80T-4000-W    | Driver Handle                   | D83T-6250-A  | Cam Remairer/Replacer Adapter           |
| D78P-4201-F    | Dial Indicator Bracketry        | T83T-6316-A  | Crank/Carn Gear and Damper Remover      |
| D78P-4201-G    | Dial Indicator — 1 Inch Travel  | T83T-6316-B  | Crank/Cam Gear and Damper Replacer      |
| D81L-4201-A    | Feeler Gauge                    | T74P-6375-A  | Flywheel Holding Tool                   |
| TOOL-4201-C    | Dial Indicator w/Bracketry      | .T83T-6500-A | Tappet Bleed-Down Wrench                |
| T77F-4220-B1   | Gear Puller                     | TOOL-6500-E  | Hydraulic Tappet Leakdown Tester        |
| T83T-6000-D6.9 | 6.9L Essential Service Tool Kit | TOOL-6505-F  | Valve Stem Clearance Tool               |
| T70P-6000-     | Engine Lifting Brackets         | T83T-6513-A  | Valve Spring Compressor                 |
| D81L-6002-B    | Plastigage                      | TOOL-6513-DD | Valve/Clutch Spring Tester              |
| D81L-6002-C    | Piston Ring Compressor          | TOOL-6565-AB | Cup Shaped Adapter                      |
| D81L-6002-D    | Piston Ring Groove Cleaner      | T83T-6571-A  | Valve Stem Seal Replacer                |
| D81P-6002-E    | Valve Seat Runout Gauge         | T83T-6700-A  | Front Crank Seal Replacer               |
| D83T-6002-A    | Glow Plug Socket                | T83T-6701-A  | Rear Crankshaft Seal Replacer           |
| D83T-6250-A    | Camshaft Installation Adapter   | T83T-6701-B  | Rear Crankshaft Seal Pilot              |
| T65L-6250-A    | Camshaft Bearing Set            | T86T-9000-C  | Injection Pump Mounting Wrench          |
| T68P-6135-A    | Piston Pin Remover/Replacer     | T83T-9000-C  | Injection Pump Rotating Tool            |
| D83L-4201-A    | Straight Edge                   | T83T-9395-A  | Fuel System Protection Cap Set          |
| T83T-6312-A    | Fan Clutch Pulley Holder        | T83T-9396-A  | Fuel Line Nut Wrench                    |
| T83T-6312-B    | Fan Clutch Nut Wrench           | T83T-9424-A  | Intake Manifold Cover                   |
| D83T-9000-E    | Throttle Control                | T83T-9527-A  | Nozzie Seat Cleaner                     |
| D83T-6015-A    | Expansion Plug Replacer         | T71P-19703-C | O-Ring Tool                             |
| D83T-6134-A    | Piston Cooling Jet Installer    | T65-6505-H   | Valve Stem Clearance Tool (7/16 Valves) |
| D83T-6085-A    | Valve Guide Tools               |              |   |

CA7423-2F

# ROTUNDA EQUIPMENT

| Model Number | Description                        |  |
|--------------|------------------------------------|--|
| 014-00036    | Universal Load Positioning Sling   |  |
| 014-00300    | Injection Nozzle Tester            |  |
| 014-00301    | Injection Nozzle Cleaning Kit      |  |
| 014-00306    | Engine Stand Mounting Adapter      |  |
| 014-00312    | Engine Lifting Bracket             |  |
| 014-00701    | Compression Tester                 |  |
| 014-00702    | Pressure Test Kit                  |  |
| 014-00726    | Oil Cooler Internal Leakage Tester |  |
| 112-00001    | Oil Leak Detector                  |  |

CA7424-1F

# **SECTION 03-03 Engine Cooling**

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|                                      |  |         |

#### **VEHICLE APPLICATION**

E-150—E-350, F-150—F-350, F-Super Duty and Bronco Vehicles.

#### DESCRIPTION

#### **Coolant Recovery System**

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

NOTE: Walter C. Avrea, the owner of patents 3,601, 181 and RE27, 965, has granted Ford Motor Company rights with respect to cooling systems covered by these patents.

The correct coolant level is essential for maximum circulation and adequate cooling. In addition, for the cooling system to perform its function, it must receive proper care. This includes keeping the radiator fins clean and periodically inspecting the cooling system for leakage.

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS **OPERATING. FAILURE TO FOLLOW THESE** INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

In production E-150—E-350, Bronco and F-150—F-350 and F-Super Duty series vehicle cooling systems are filled with a 50/50 solution of Ford Cooling System Fluid and water which prevents corrosion, keeps the cooling system clean, provides antifreeze protection to -28.8 to -37.2°C (-20 to -35°F) in winter and provides for higher summer operation temperatures.

NOTE: A coolant mixture of 50 percent coolant concentrate and 50 percent water is recommended to maintain best overall performance. To avoid damaging the radiator, the coolant concentrate should not exceed 60 percent.

#### **DESCRIPTION (Continued)**

For the most effective cooling system operation, this mixture strength should be maintained all year round and in all climates. Refer to Draining, Filling and Bleeding the Cooling System in this Section.

Coolant should be the specified mixture of Ford Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A or ESE-M97B43-A), or equivalent and water. If Ford Cooling System Fluid is not available, another reputable permanent antifreeze meeting Ford specification ESE-M97B44-A must be used and diluted with an equal quantity of tap water.

Some engine coolant recycling manufacturers have claimed to have the ability to recycle engine coolant. Ford Motor Company has **not** authorized the use of recycled engine coolant nor have they sanctioned the use of any machines or devices that recycle engine coolant. Recycled coolant is **not** equivalent to the factory fill OEM coolant, the Ford premium cooling system fluid, E2FZ-19549-AA or equivalent, or the Ford heavy duty low silicate cooling fluid E6HZ-19549-A or equivalent.

Further, the disposal of all used engine coolant MUST ALWAYS BE DONE in accordance with all applicable federal, state and local laws and regulations.

Ordinary tap water may be used in an emergency except in areas where the water is known to be exceptionally hard or to have a high alkali content. The cooling system should be drained and flushed and the proper mixture of antifreeze added as soon as possible.

To avoid possible overheating in very hot weather, do not use mixtures with more than 50 percent antifreeze except in areas where antifreeze protection below 1.7°C (35°F) is required. In this case, refer to the coolant mixture chart on the Ford Premium Cooling System Fluid container.

A standard ethylene glycol hydrometer or Rotunda Anti-Freeze Tester 021-00046 or equivalent can be used to check the protection level of the long-life coolant.

When water or antifreeze must be added to the cooling system during periods of below freezing ambient temperature, always operate the engine at fast idle for 30 minutes before letting the vehicle stand with the engine off for prolonged periods. This will create a uniform mixture throughout the cooling system and prevent damage by freezing, when sufficient antifreeze is used.

If the fan drive belt(s) is noisy, check the tension of the belt(s) to make certain it is within specifications. Also, check for misaligned pulleys. If the drive belt(s) is worn or frayed, replace it. Refer to Section 03-05, Engine Accessory Drive.

Coolant recovery systems are standard on F-150—F-350, F-Super Duty series vehicles and Bronco. It is also standard on E-250—E-350 with 7.3L Diesel engine. Maintain the coolant level in the radiator flush with the cap seal in the filler neck to 38mm (1.5 inches) below the cap seal.

CAUTION: Do not remove the radiator cap when the cooling system is hot.

#### **Thermostat**

A poppet-type thermostat is used with all engines.

When the thermostat is closed, coolant flows to the water pump through a bypass passage at the front of the engine. When the thermostat is open, coolant flows through the coolant outlet elbow (thermostat housing) to the radiator.

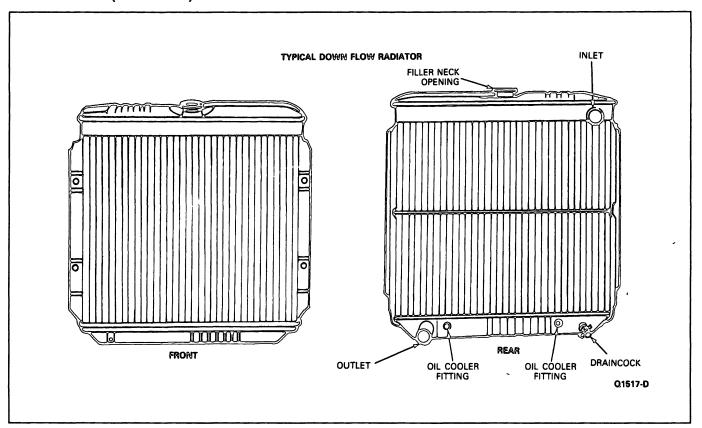
The thermostat used in production is a high temperature thermostat for use with a mixture of water and permanent-type antifreeze. A low temperature thermostat should be installed if a non-permanent type antifreeze and water coolant solution is used (except on trucks with automatic radiator shutters).

#### Radiator

#### E-150—E-350—Gasoline Engines

All radiators are of the tube and fin type with the tubes arranged for vertical flow of the coolant. Two header tanks, one on the top and one on the bottom of the radiator provide uniform distribution of the coolant to the tubes. The radiator outlet port (lower tank) is connected to the water pump inlet port. The radiator inlet port (upper tank) is connected to the coolant outlet elbow of the engine, thereby permitting coolant circulation through the radiator when the thermostat is open.

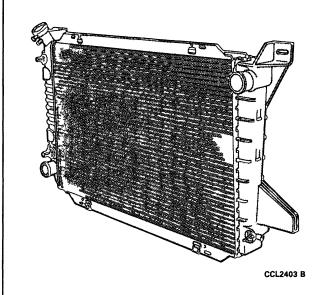
# **DESCRIPTION (Continued)**



# F-150—F-350, F-Super Duty Chassis Cab, Motorhome Chassis and Bronco—Gasoline Engines

All radiators are the tube and fin type with the tubes arranged for horizontal flow of the coolant. Two header tanks, one on each end of the radiator, allow uniform distribution of engine coolant to the radiator tubes. The radiator outlet port (lower hose connection) is connected by a hose to the water pump inlet port. The radiator inlet port (upper hose connection) is connected by the hose to the coolant outlet elbow of the engine, allowing coolant circulation through the radiator when the engine thermostat is open.

The crossflow radiator used with gasoline engines is constructed with a vacuum brazed aluminum core and nylon end tanks. The nylon end tanks are attached to the aluminum core by bending tabs on the core header over the edge of the nylon tank. An O-ring gasket is placed between the nylon tank and the radiator core header to achieve a seal between the tank and the radiator core header. The nylon tanks are a molded one piece design with the mounting brackets part of each tank.

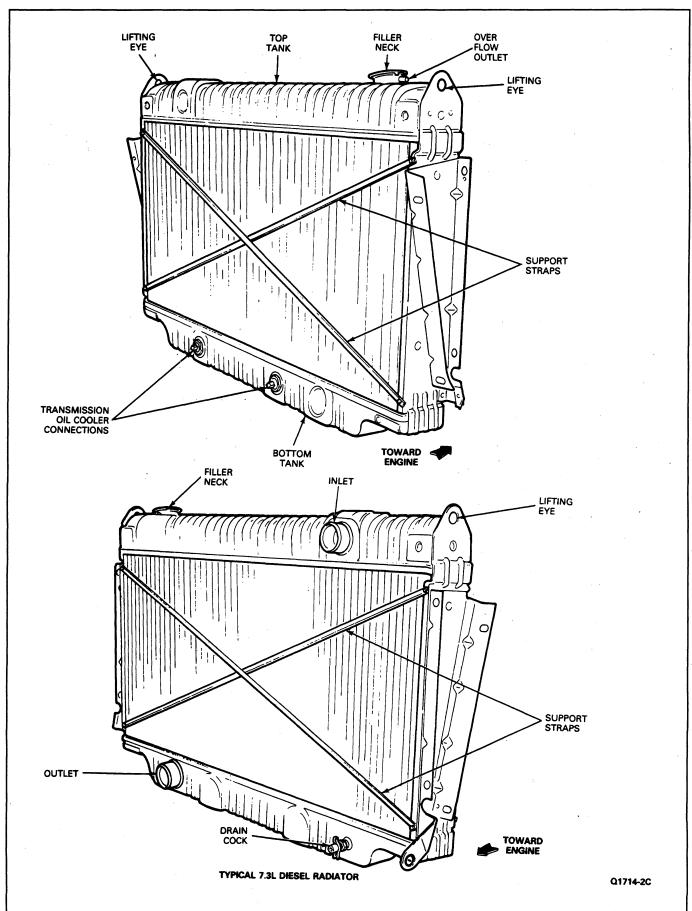


F-250—F-350, F-Super Duty Chassis Cab, Commercial Stripped Chassis and E-250—E-350—7.3L Diesel Engine

The vertical flow radiator used with the 7 3L diesel engine is the conventional copper/brass design similar to the E-Series gasoline engine radiators

However, the diesel radiator uses turbulator type tubes and cannot be rodded out

# **DESCRIPTION (Continued)**



#### **OPERATION**

# Draining, Filling and Bleeding the Cooling System

To prevent loss of coolant when draining the radiator, attach a hose on the radiator draincock and drain the coolant from the radiator into a clean container.

To drain the radiator, open the draincock located at the bottom of the radiator and remove the radiator cap or supply tank cap. The cylinder block of the V-8 engine is drained by removing the drain plugs located on both sides of the block. The 6-cylinder engines have one drain plug located at the left rear of the cylinder block.

To fill the cooling system, install the cylinder block drain plug(s) and close the radiator draincock. Disconnect the heater outlet hose at the water pump to bleed or release trapped air in the system. When the coolant begins to escape, connect the heater outlet hose.

Fill the radiator until the coolant is between the cap seal in the filler neck to 38mm (1.5 inches) below the cap seal. Install cap.

# WARNING: DO NOT STAND IN LINE WITH OR NEAR ENGINE COOLING FAN WHEN ENGINE IS RUNNING.

Start engine, warm up, shut off engine. Allow engine to cool, remove cap and check coolant level. Fill as required.

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A **CLOTH), TURN AND REMOVE IT.** 

# **DIAGNOSIS AND TESTING**

#### **Visual Inspection**

- 1. Check for leaks at:
  - a. All hoses and hose connections.
  - b. Radiator seams, radiator core, and radiator drain petcock.
  - c. All block core plugs and drain plugs.
  - d. Edges of all other cooling system gaskets.
  - e. Transmission oil cooler.
  - Vehicle heating system components.

- g. Water pump.
- Examine oil dipstick for evidence of engine oil contaminated with coolant.
- 3. Check radiator for evidence of oil in coolant (leakage at transmission oil cooler).

Install the analyzer from Rotunda Cooling System Pressurization Kit 021-00012 or equivalent to assist in testing the cooling system. Follow the manufacturer's recommended connections and testing procedures.

# **Cooling System Pressure Test**

1. Shut the engine off.

**WARNING: NEVER REMOVE THE RADIATOR** CAP UNDER ANY CONDITIONS WHILE THE **ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD** RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT **COOLANT OR STEAM BLOW OUT OF THE** RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

- Adjust the radiator coolant level (fill or drain) to 25mm (one inch) below the filler neck opening before testing. Wipe clean, and then wet the rubber sealing surfaces in the cap and filler neck before installing the cap tightly on the radiator.
- 3. Disconnect the electrical connector from the coolant temperature sending unit and remove the temperature sending unit from the engine.

With the radiator cap installed and the cooling system pressure relieved, only a small amount of coolant will be lost when the sending unit is removed.

- 4. Install the adapter fitting from Rotunda Cooling System Pressurization Kit 021-00012 or equivalent (male thread on one end, and a hose connector on the other end to accommodate the tester hose) tightly into the intake manifold or cylinder head in place of the sending unit.
- 5. On E-150—E-350, remove the radiator overflow hose from the retainer clips. If vehicle is equipped with an expansion bottle system, use a separate hose. Make sure the hose is firmly installed on the radiator overflow nipple and is in good condition. Insert the free end of the overflow hose into a container of water.

- 6. On Bronco and F-150—F-350 and F-Super Duty, series vehicles, remove the radiator overflow hose from the overflow nipple. Install a separate hose firmly on the overflow nipple. Insert the free end of separate hose into container of water.
- Attach the pressure pump and gauge to the adapter-fitting and pressurize the cooling system to the cap LOWER LIMIT as shown in the test chart.

No bubbles should appear in the water container when the system is pressurized to the LOWER LIMIT. If the system is satisfactory at the lower limit, gradually increase the system pressure until a slight stream of bubbles appears in the water container. This is the release pressure of the pressure cap.

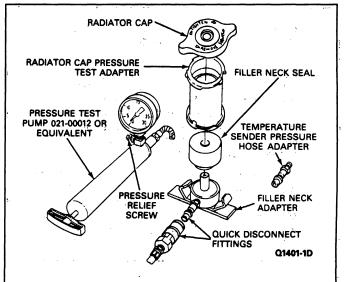
Replace any radiator cap which has a release pressure that is greater than the specified UPPER LIMIT pressure without discharging bubbles. Refer to Specifications at the end of this section.

 If the radiator cap does not hold pressure, remove and wash the cap in clean water to dislodge all foreign particles from the gaskets. Check the sealing surface in the radiator filler neck.

Inspect the cam lock flanges on both sides of the filler neck for maximum cap engagement.

Pressurize the cooling system as outlined in step
7 (using a radiator cap that operates within the
specified upper and lower pressure limits) and
observe the gauge reading for approximately two
minutes. Pressure should be held between 69 and
89 kPa (10 and 13 psi) and should not drop
during this time.

RESULTS: If the pressure drops, check for leaks at the engine-to-heater core hoses, engine-to-radiator hoses, bypass hose, water valve hose (if applicable), thermostat housing gasket, radiator and heater core, etc. Also refer to engine system checks if a leak cannot be located in the cooling system. Any leaks which are found must be corrected and the system checked again.



If the system holds pressure proceed to step 10.

 Release the system pressure by loosening the radiator cap and removing the adapter. Install the temperature sending unit, check coolant level and replenish, if necessary, with the correct coolant solution.

# **Radiator Cap Pressure Test**

- Remove the radiator cap from the radiator filler neck.
- Use water to clean the cap in the area of the rubber seal and the vacuum relief valve as outlined. Immerse the radiator cap in water to wet the seals and install on the shallow filler neck of Rotunda Radiator Cap Pressure Test Adapter 021-00012 or equivalent adapter.

NOTE: The adapter is designed to accept both deep and shallow neck radiator caps.

 Before installing the radiator cap on the adapter, immerse the filler neck seal in water and install it in the filler neck adapter. If the adapter is made of plastic, check its sealing surfaces to be certain that they are free of rough spots and contain no parting lines or core marks.

NOTE: The filler neck seal is reversible so that it may be used on either a deep or shallow radiator filler neck. It will also fit either end of the radiator cap pressure test adapter.

- Install the filler neck adapter with filler neck seal on the deep filler neck end to the radiator cap pressure test adapter.
- Connect the female quick disconnect fitting of the pressure test pump to the male quick disconnect fitting of the filler neck adapter.
- SLOWLY depress the plunger of the pressure test pump until the pressure gauge reading stops increasing and note the highest pressure reading obtained.

NOTE: If the plunger of the pump is depressed too fast, an erroneous pressure reading will result.

- 7. Release the pressure by depressing the pressure relief valve stem. Then, tighten the pressure relief screw and repeat Step 6 (at least twice) to ensure that the pressure test reading is repeatable within the acceptable gauge reading limits of the radiator cap and is not erratic. Refer to Specifications at end of this section.
- If the pressure test gauge readings are not within the acceptable gauge reading limits, replace the radiator cap, and perform a cooling system pressure test. If the pressure test gauge readings are within the acceptable gauge reading limits, perform the Cooling System Pressure Test.

#### **Thermostat Test**

If the problem being investigated is insufficient heat, inspect the thermostat for leakage. This may be done by holding the thermostat up to a lighted background. Light leakage around the thermostat valve (thermostat at room temperature) is unacceptable and the thermostat should be replaced. It is possible, on some thermostats, that a slight leakage of light at one or two locations on the perimeter of the valve may be detected. This should be considered normal.

#### **Leak Test**

Clean the radiator before leak testing to prevent contaminating the test tank. Leak test the radiator in clean water at 145 kPa (21 psi) air pressure.

CAUTION: Do not leak test an aluminum radiator in the same water that is used to leak test copper/brass radiators. Flux and caustic cleaners may be present in the tank and they will attack aluminum.

A separate, clean test tank is recommended for aluminum radiators. If a separate tank is not available for aluminum radiator testing, thoroughly clean the test tank each time before testing an aluminum radiator.

NOTE: When a plastic tank is removed to service a tube-to-header leak, the core can be tested by clamping the tank to the core.

# **Diagnosis Guides**

Refer to the following Diagnosis Guides for cooling system complaints, their possible cause and recommended resolution. Refer to the pertinent Section for testing and service.

Use a cooling system analyzer or equivalent to assist in diagnosing the cooling system. Follow the manufacturer's instructions for connections at testing.

The most frequent cooling system complaints concern leakage and overheating. Either of these problems will soon render the vehicle inoperable.

Most vehicles use an ethylene glycol base antifreeze solution to which the manufacturers have added a dye color. The dye color makes the antifreeze solution an excellent leak detector. If this type of solution is not being used in the cooling system, a vegetable dye may be added to aid in locating external leakage.

|           | TEST STEP  | RESULT                        | ACTION TO TAKE  |
|-----------|--|-------------------------------|---|
| A0        | VISUAL CHECK   |                               |   |
|           | Make visual check for leaking hoses, and connections to radiator, heater core and engine.  | 6                             | GO to A1.   |
|           |  | <b>(</b>                      | Make necessary repairs.<br>GO to A1.  |
| <b>A1</b> | PRESSURE TEST  |                               |   |
|           | <ul> <li>Pressure test cooling system to check for dirty or<br/>damaged radiator cap, external leakage and/or<br/>internal leakage.</li> </ul> | 6                             | RETURN vehicle to customer.   |
|           |  | Dirty or damaged radiator cap | CLEAN or REPLACE cap. REPEAT A1.  |
|           |  | External Leak                 | REPAIR or REPLACE as necessary. REPEAT A1.  |
|           |  | Internal Leak                 | DISASSEMBLE engine as necessary to determine cause of leakage. CHECK for: cracked intake manifold, blown head gasket, |
|           |  |                               | warped block or head<br>gasket surfaces, cracked<br>cylinder head(s), cracked<br>cylinder block. REPAIR               |
|           |  |                               | or REPLACE as necessary. REPEAT A1.   |

# ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE DIAGNOSIS GUIDE

|    | TEST STEP  | RESULT | ACTION TO TAKE                             |
|----|--|--------|--|
| B1 | TEMPERATURE CHECK (DOWN FLOW RADIATOR ONLY)  |        |  |
|    | Operate engine at high RPM or under load for 20  | ok▶    | GO to B2.                                  |
|    | minutes. Check coolant temperature with thermometer. WARNING: USE CARE WHEN REMOVING RADIATOR CAP TO AVOID INJURY FROM ESCAPING STEAM OR HOT WATER. NOTE: Remove radiator cap before running this test. Then use a known quality thermometer for checking coolant temperature. | NOTOK₽ | GO to <b>B3</b> .                          |
| B2 | GAUGES/LIGHTS  |        | ,  |
|    | <ul> <li>Check operation of temperature gauge (Refer to<br/>Section 13-05, Engine Operation Gauges.)</li> </ul>  | ok▶    | RELEASE vehicle to customer.               |
|    |  | NOTOK▶ | REPAIR or REPLACE components as necessary. |

# ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE DIAGNOSIS GUIDE (Continued)

|    | TEST STEP   | RESULT   | ACTION TO TAKE                              |
|----|---|----------|---|
| В3 | THERMOSTAT  |          |   |
|    | <ul> <li>Remove and test thermostat. (Refer to Thermostat<br/>Testing, in this Section.)</li> </ul> | ok▶      | RELEASE vehicle to customer.                |
|    |   | NOT OK ▶ | REPLACE the thermostat.<br>GO to <b>B1.</b> |

# **ENGINE OVERHEATS DIAGNOSIS GUIDE**

|    | TEST STEP   | RESULT                          | <b>&gt;</b>      | ACTION TO TAKE  |
|----|---|---------------------------------|------------------|---|
| C1 | COOLANT   |                                 |                  |   |
|    | Check coolant level.  |                                 | OK ►<br>NOT OK ► | J. J  |
| C2 | TEMPERATURE CHECK—(DOWN FLOW RADIATOR ONLY)   |                                 |                  |   |
|    | <ul> <li>Operate engine at high RPM or under load for 20 minutes. Check temperature with a thermometer.</li> <li>CAUTION: USE CARE WHEN REMOVING RADIATOR CAP TO AVOID INJURY FROM ESCAPING STEAM OR HOT WATER. IF ENGINE OVERHEATS, SHUT DOWN IMMEDIATELY AND GO TO C4. NOTE: Remove radiator cap before running this test.</li> </ul> | Temperature too low Temperature | OK ►<br>►        | GO to C3.  GO to Engine Fails to Reach Normal Operating Temperature Diagnosis Guide in this Section.  GO to C4. |
|    | T   | too high                        |                  |   |
| C3 | TEMPERATURE GAUGE     Check operation of temperature gauge. (Refer to Section 13-05, Engine Operation Gauges.)  |                                 | ок▶              | RELEASE Vehicle to customer.  |
|    |   |                                 | NOTOK▶           | REPAIR or REPLACE components as necessary.  |
| C4 | FAN BELT  |                                 |                  |   |
|    | <ul> <li>Check fan belt tension. (Refer to Section 03-05,<br/>Engine Accessory Drive.)</li> </ul>   |                                 |                  | GO to C5.  REPLACE fan belt and / or ADJUST belt tension. GO to C2.   |
| C5 | RADIATOR  |                                 |                  |   |
|    | Check radiator fins for obstructions.   |                                 | OK►<br>NOTOK►    |   |
| C6 | SYSTEM CIRCULATION  |                                 |                  |   |
|    | Remove radiator cap. Operate engine at high RPM.  |                                 | ок►              | GO to <b>C7.</b>  |
|    | Coolant should not overflow radiator filler neck.   |                                 | NOTOK▶           | GO to <b>C9.</b>  |
| C7 | DISTRIBUTOR BASICS  |                                 |                  |   |
|    | <ul> <li>Check ignition initial timing and distributor advance.<br/>(Refer to the Technical Bulleting Special<br/>Specifications Issue for distributors.)</li> </ul>  |                                 | OK►<br>NOTOK►    | GO to C8.  MAKE adjustments, repairs, and/or parts replacements as necessary. GO to C2.                         |

| TEST STEP |  | RESULT   | ACTION TO TAKE  |
|-----------|--|----------|---|
| C8        | WATER PUMP   |          |   |
|           | <ul> <li>Remove water pump and check for binding or<br/>sheared impeller shaft.</li> </ul>   | ок▶      | REINSTALL water pump and RELEASE vehicle to customer. |
|           |  | NOT OK ▶ | REPLACE water pump.<br>GO to <b>C2.</b>               |
| C9        | THERMOSTAT   |          |   |
|           | Check thermostat operation. (Refer to Thermostat   | ок▶      | GO to <b>C10.</b>                                     |
|           | Test in this Section.)   | NOT OK ▶ | REPLACE thermostat. GC to C2.                         |
| C10       | COOLING SYSTEM   |          |   |
|           | <ul> <li>Flush, clean and refill cooling system. (Refer to<br/>Cleaning and Inspection in this Section.) Repeat test<br/>step C2.</li> </ul> | ok▶      | RELEASE vehicle to customer.                          |
|           |  | NOTOK▶   | GO to <b>C11</b> .                                    |
| C11       | FAN CLUTCH   |          |   |
|           | <ul> <li>Check automatic fan drive system operation. (Refer<br/>to Section 03-05, Engine Accessory Drive.)</li> </ul>                        | ок▶      | RELEASE vehicle to customer.                          |
|           |  | NOTOK▶   | REPLACE fan clutch and GO to C2.                      |

#### **CLEANING AND INSPECTION**

#### **Radiator Coolant Level Check**

Engine should be at normal operating temperature.

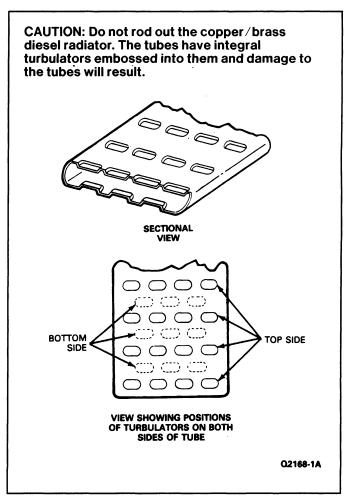
In addition to maintaining the correct coolant level, the radiator fins must be cleaned and the cooling system inspected periodically for leaks in order to be sure the system operates at maximum efficiency.

Check the cooling system for dirty or rusty appearance. Dirty or rusty coolant requires replacement to protect the cooling system from corrosion damage.

# **Cleaning Cooling System**

To remove rust, sludge and other foreign material from the cooling system, use Ford Premium Cooling System Flush D6AZ-19A503-AA (ESR-M14P7-A), or equivalent. Removal of such material restores cooling efficiency and avoids overheating. Always remove the thermostat prior to pressure flushing. A pulsating or reversed direction of flushing water flow will loosen sediment more quickly than a steady flow in the normal direction of coolant flow. In severe cases where cleaning solvents will not properly clean the cooling system for efficient operation, it will be necessary to use the pressure flushing method. Various types of flushing equipment are available.

Do not back-flush cooling systems that have a water shutoff valve in the heater system, or damage to the valve can result.



# **Heater Core Back-Flushing**

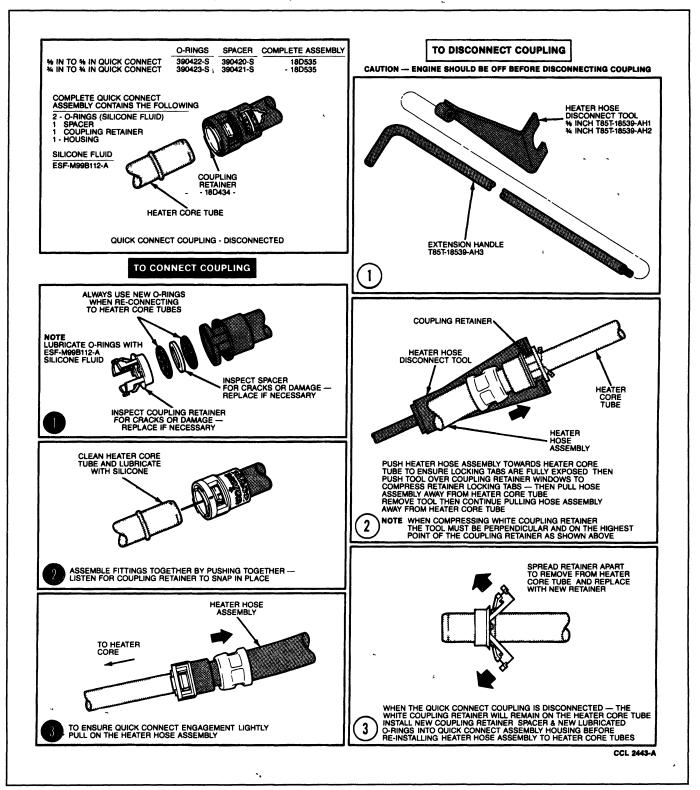
All engine cooling system flushing and back-flushing procedures must include a separate back-flushing of the heater or A / C-Heater system heater core, after the flushing or back-flushing of the engine cooling system. This will prevent engine cooling system particles from clogging the heater core tubes and reducing (or eliminating) coolant flow through the heater core.

The heater core must be back-flushed separately from the engine cooling system for proper back-flush water flow direction through the heater core.

The correct heater core back-flushing procedure is as follows:

 On F-Series and Bronco vehicles, disconnect the heater core outlet heater hose from the water pump fitting and install a female garden hose-end fitting adapter in the end of the outlet heater hose. Secure with a hose clamp.

On Econoline vehicles, disconnect the heater core outlet hose from the heater core. Then, fabricate a jumper hose with a Quick Connect Coupling Assembly (Part No. 18D535) on one end and a female garden hose fitting on the other end. Attach the jumper hose to the heater core outlet tube.



- 2 Connect the female garden hose-end of the outlet heater hose to the male end of a water supply garden hose
- 3 Disconnect the heater core inlet heater hose from the engine block fitting and allow to drain onto the ground or into a floor drain
- If a water valve is installed in the heater core inlet heater hose, check to be certain the water valve is open (no vacuum)

- 5 Turn the water supply valve on and off several times so that the surge action will help to dislodge larger stubborn particles from the heater core tubes. Allow full water pressure to flow for approximately five minutes.
- 6 If a water valve is installed in the heater core inlet heater hose, apply vacuum to the water valve vacuum motor to ensure proper operation of the water valve and proper closure with no water leakage Replace the water valve if required
- 7 Remove the hose clamp and female garden hose-end adapter from the end of the outlet heater hose and connect the outlet heater hose onto the water pump fitting
- 8 Connect the inlet heater hose onto the engine block fitting
- 9 Fill the cooling system, as outlined
- 10 Test the system for proper heater performance with the specified engine cooling system conditions

#### **Radiator Pressure Cap**

- Inspect the areas under the vacuum valve and rubber seal for rust or dirt particles
- 2 Using warm tap water, raise and clean the vacuum valve and rubber seals. Thoroughly flush away loose rust or dirt particles trapped under the vacuum valve and rubber seal and on the surfaces of the seals.
  - SEAL SURFACE RUBBER SEAL

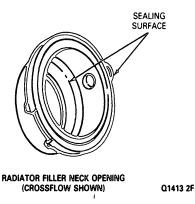
    UNDER SEAL

    OVERFLOW SYSTEM SEAL WITH RECOVERY SYSTEM

    RADIATOR CAP

- 3 Inspect and remove any imbedded rust or dirt particles on the sealing surfaces of the rubber seal
- Inspect the radiator filler neck opening for rust or dirt particles on the sealing surface at the bottom of the filler neck opening. Use a clean cloth and wipe the sealing surface to remove any rust or dirt particles.

NOTE If paint is observed on the filler neck sealing surface, remove it using paint thinner



#### REMOVAL AND INSTALLATION

#### **Thermostat**

Do not attempt to service the thermostat It should be replaced if it is not operating properly

Check the thermostat before installing it following the Thermostat Test procedures

#### 4.9L (300 CID) I-6

#### Removal

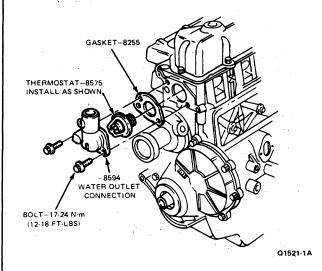
- 1 Drain the radiator so that the coolant level is below the thermostat
- 2 Remove the coolant outlet elbow attaching bolts Pull the elbow away from the cylinder head sufficiently to provide access to the thermostat Remove the thermostat and gasket

#### Installation

- 1 Clean the coolant outlet elbow and cylinder head gasket surfaces Coat a new gasket with water resistant sealer Position the gasket on the cylinder head opening. The gasket must be positioned on the cylinder head before the thermostat is installed.
- 2 The coolant outlet elbow contains a locking recess into which the thermostat is turned and locked Install the thermostat with the bridge section in the outlet elbow. Turn the thermostat clockwise to lock it in position on the flats cast into the outlet elbow.
- 3 Position the coolant outlet elbow against the cylinder head. Install and tighten the attaching bolts. Refer to Specifications.

# WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

 Fill and bleed the cooling system as outlined. Check for leaks and proper coolant level after the engine has reached normal operating temperatures.



#### **V-8**

#### Removal

- Drain the radiator so that the coolant level is below the thermostat.
- Disconnect the bypass hoses at the water pump and intake manifold. Remove the bypass tube. Remove the water outlet housing attaching bolts. Bend the radiator upper hose upward and remove the thermostat and gasket.

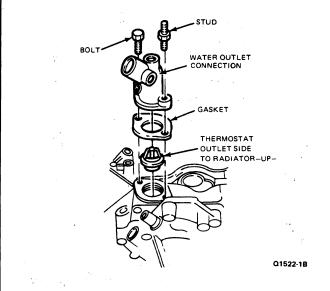
#### Installation

- Clean the water outlet housing gasket surfaces. Coat a new water outlet housing gasket with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A or ESE-M4G115-A) or equivalent. Position the water outlet housing gasket on the intake manifold opening.
- Install the thermostat in the intake manifold opening with the copper pellet or element toward the engine and the thermostat flange positioned in the recess. If the thermostat is improperly installed, it will cause a retarded flow of coolant.

 Position the water outlet housing against the intake manifold. Install and tighten the attaching bolts. Refer to Specifications. Install the water bypass line and tighten hose connections.

# WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

Fill and bleed the cooling system as outlined.
 Operate the engine until normal operating temperature is reached; then check the coolant level and check for leaks.



# **Coolant Recovery Bottle**

#### Removal

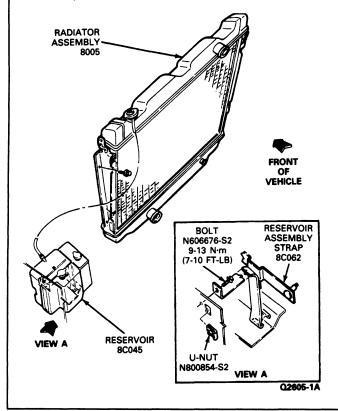
- Drain the radiator until the coolant is out of the recovery bottle. Disconnect the radiator overflow line at the recovery bottle.
- Remove the overflow tube from the recovery bottle. Remove the recovery bottle strap or bracket attaching bolt(s) and remove the recovery bottle.

# Installation

- Position the recovery bottle in the chassis and install the strap or bracket attaching bolt(s).
- Connect the overflow tube to the recovery bottle.

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

 Fill and bleed the cooling system as outlined. Check for coolant leaks and proper coolant level after the engine reaches normal operating temperatures.



# **Radiator and Fan Shroud**

E-150-E-350-All Engines

F-250—F-350, F-Super Duty Chassis Cab and Commercial Stripped Chassis with—7.3L Diesel Engine

Refer to the illustrations following step 10 of Installation.

#### Removal

- Drain the cooling system by removing the radiator cap and opening the drain cock located at the lower rear corner of the radiator tank. To prevent coolant loss when draining radiator, slip a hose on the draincock and drain coolant into a clean container.
- Remove the rubber overflow tube from the coolant recovery bottle and detach it from the shroud (where appropriate).
- 3. Remove the shroud's two or four attaching bolts, lift the shroud back and drape it on the fan.

- Loosen the upper and lower hose clamps at the radiator and remove the hoses from the radiator connectors.
- Disconnect the two automatic transmission (if so equipped) oil cooling lines from radiator fittings.
- Disconnect the heated water bypass hose attached to the lower tank (E4OD equipped vehicles only).
- 7. Remove the four radiator attaching bolts.
- Tilt the radiator back approximately 25mm (one inch) and lift directly upward, clear of the radiator support.
- If either hose is to be replaced, loosen clamp at the engine end and slip the hose off the connection with a twisting motion.
- Lift the shroud off the fan and remove from the vehicle.

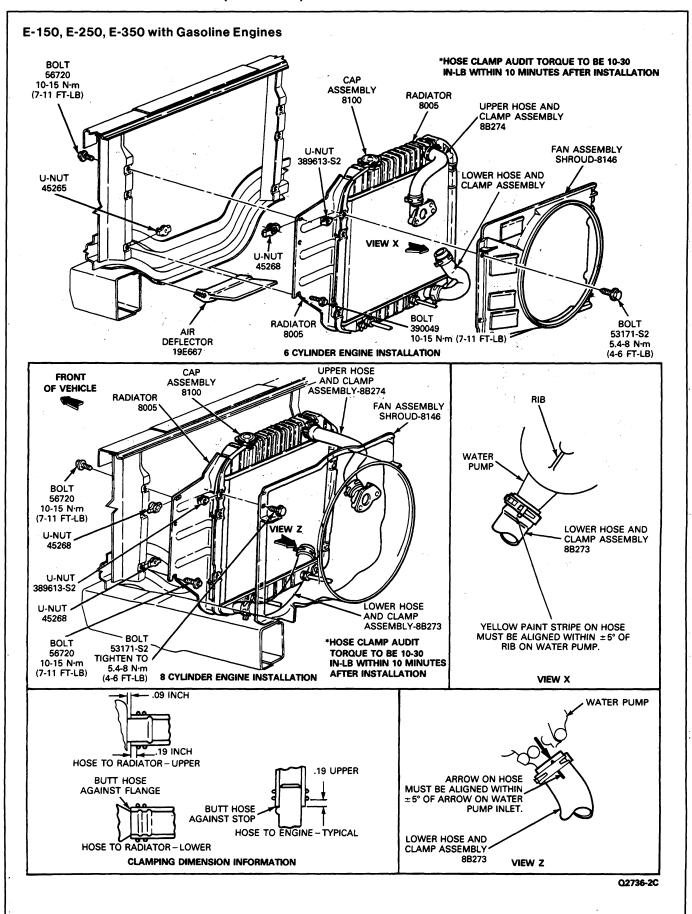
#### Installation

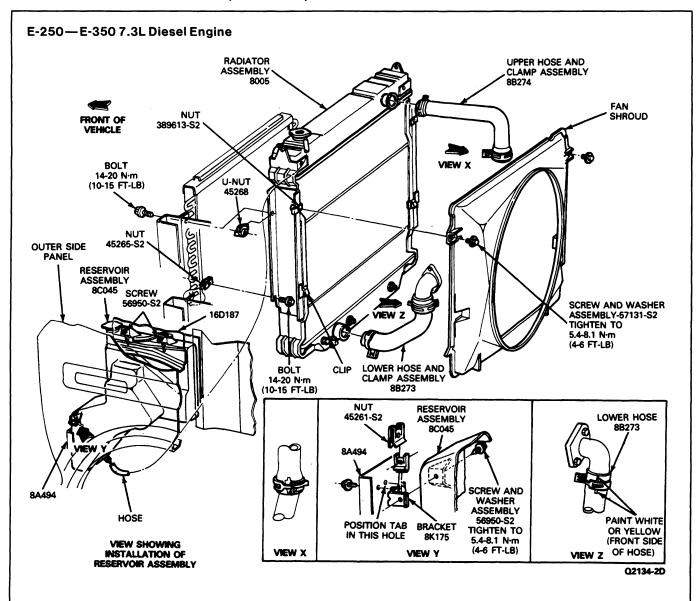
- 1. Position shroud on fan until radiator is installed.
- If either hose has been replaced install on engine and tighten clamps to 2.25-3.38 N·m (20-30 in-lbs).
- Position radiator into engine compartment to radiator support, being careful to clear fan.
- 4. Install the radiator with four bolts and tighten to 14-20 N·m (10-15 ft-lbs).
- Connect the two automatic transmission (if so equipped) oil cooling lines to radiator connectors.
- Attach upper and lower radiator hoses and clamps.
- Attach the heated water bypass hose (E4OD equipped vehicles only).
- 8. Position shroud to radiator and attach with four bolts. Tighten bolts to 5.4-8 N-m (4-6 ft-lbs).
- 9. Attach rubber overflow tube from coolant recovery bottle to radiator (where applicable).

# WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

NOTE: A coolant mixture of 50 percent coolant concentrate and 50 percent water is recommended to maintain best overall performance. To avoid damaging the radiator the coolant concentrate should not exceed 60 percent.

 Install new 50 / 50 mixture of water and ethylene glycol and operate the engine for 15 minutes. Check the coolant level and bring it up to within 38mm (1-1/2 inches) of the radiator filler neck. Add two cooling system protection pellets. Part Number D9AZ-19558-A or equivalent.





# F-150—F-350, F-Super Duty Chassis Cab and Motorhome Chassis with Gasoline Engine

Refer to illustrations following Installation step 12.

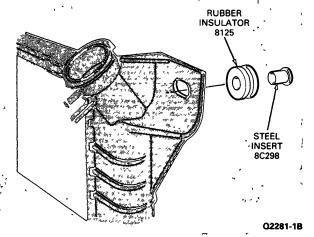
#### Removal

- Drain the cooling system by removing the radiator cap and opening the draincock located at the lower rear corner of the radiator tank. To prevent coolant loss when draining radiator, slip a hose on the draincock and drain coolant into a clean container.
- Remove the rubber overflow tube from the coolant recovery bottle and detach it from the radiator.
- Remove the shroud's two upper attaching screws, lift the shroud out of the lower retainer clips and drape it on the fan. On F-Super Duty Motor Home Chassis vehicles remove the two screws at the bottom of the shroud.
- Loosen the upper and lower hose clamps at the radiator and remove the hoses from the radiator connectors.
- Remove the heated water bypass hose (E4OD equipped vehicles only), located directly below the overflow nipple on the radiator outlet tank.
- 6. Disconnect the two automatic transmission (if so equipped) oil cooling lines from radiator fittings.
- Remove the two radiator upper attaching screws or bolts.
- 8. Tilt the radiator back approximately 25mm (one inch) and lift directly upward, clear of the radiator support and cooling fan.
- If either hose is to be replaced, loosen clamp at the engine end and slip the hose off the connection with a twisting motion.
- Lift the shroud off the fan and remove from the vehicle.
- 11. Remove the radiator lower support rubber pads (insulators).

#### Installation

- Position the radiator lower support rubber pads to the lower frame.
- 2. Position shroud on fan until radiator is installed.
- If either hose has been replaced, install on engine with index arrow in line with mark on fitting on engine. Install clamps.
- Install the heated water bypass hose (E4OD equipped vehicles only), to the nipple located below the overflow tank.

- Position radiator into engine compartment to radiator support, being careful to clear fan.
- 6. Inspect the radiator upper rubber insulators. Replace if necessary.

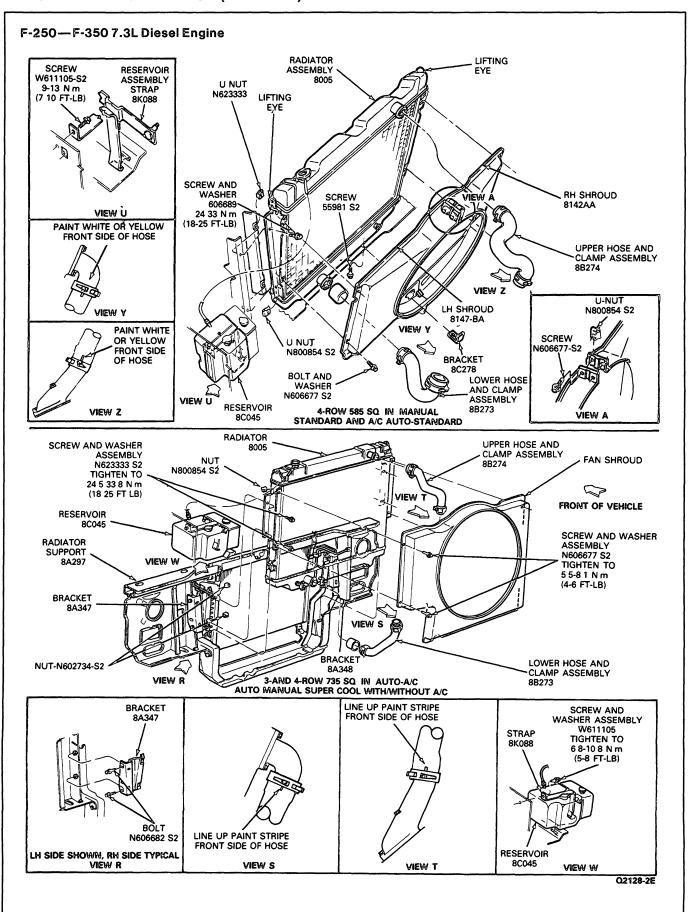


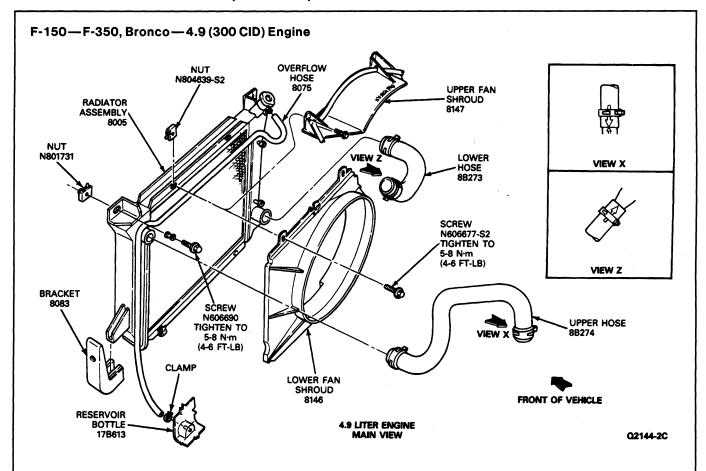
- 7. Install two upper attaching bolts or screws. Tighten to 11-14 N·m (8-11 ft-lb).
- 8. Connect the two automatic transmission (if so equipped) oil cooling lines to radiator connectors.
- 9. Attach radiator upper and lower hoses to radiator. Position hose on radiator connection so that index arrow on hose is in line with mark on connection. Install hose clamps.
- 10. Position shroud on the lower retainer clips and attach the top of the shroud to radiator with two screw and washer assemblies. On F-Super Duty Motorhome Chassis vehicles install the 2 lower screws. Tighten screws to 5.5-8 N·m (4-6 ft-lbs).
- 11. Attach rubber overflow tube from coolant recovery bottle to radiator.

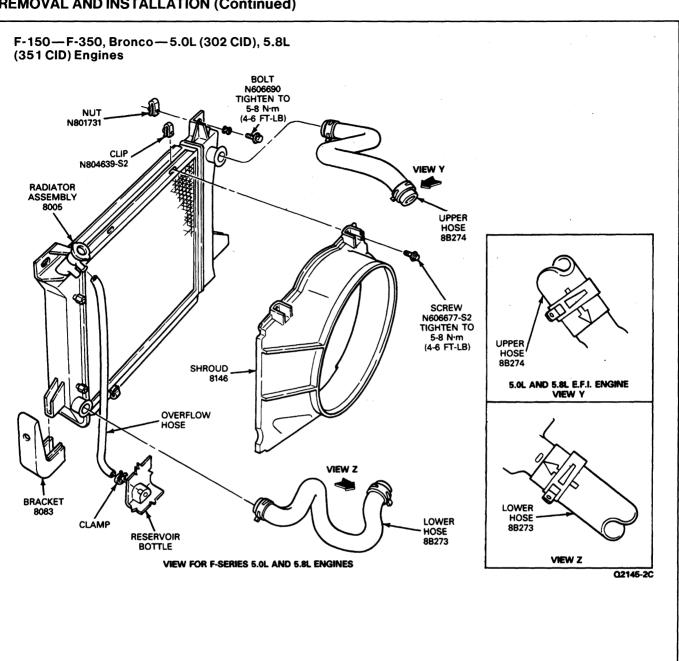
WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

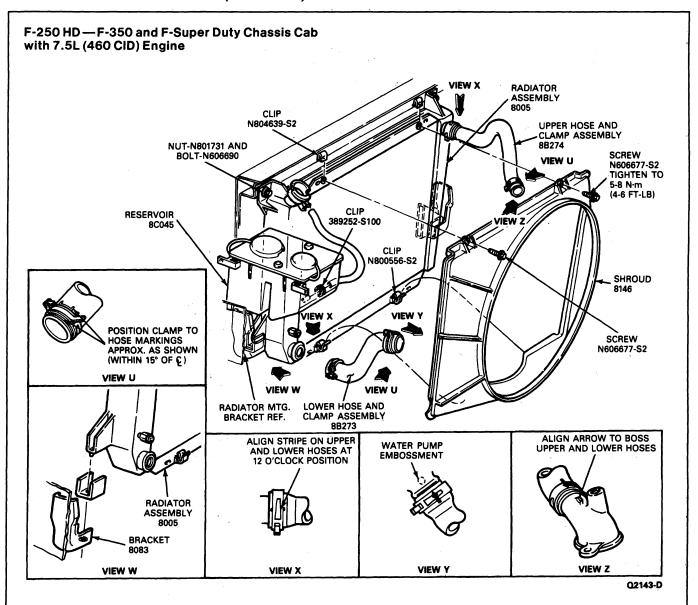
NOTE: A coolant mixture of 50 percent coolant concentrate and 50 percent water is recommended to maintain best overall performance. To avoid damaging the radiator, the coolant concentrate should not exceed 60 percent.

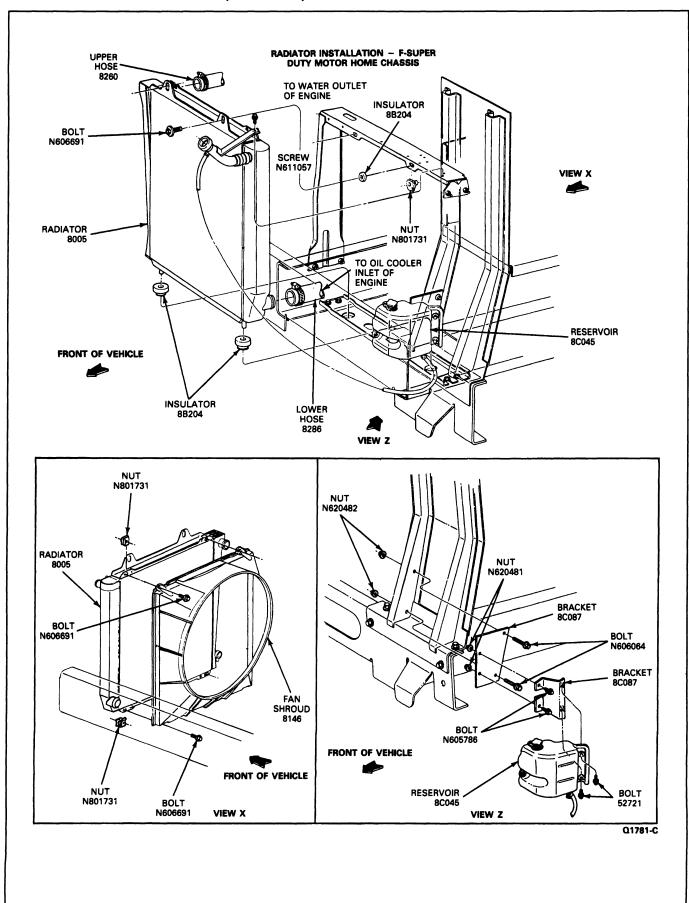
12. Install new 50/50 mixture of water and ethylene glycol and operate the engine for 15 minutes. Check the coolant level and bring it up to within 38mm (1-1/2 inches) of the radiator filler neck. Add two cooling system protection pellets, Part Number D9AZ-19558-A or equivalent.









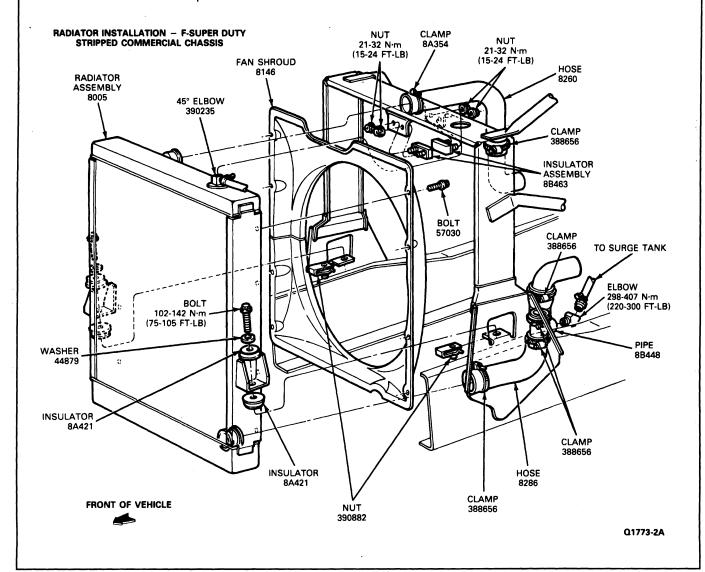


# Radiator and Fan Shroud — F-Super Duty Commercial Stripped Chassis

#### Removal

- Drain the radiator by removing the radiator cap and disconnecting the lower radiator hose. To prevent coolant loss when draining the radiator, drain the radiator into a clean container.
- 2. Remove the rubber overflow tube from the coolant recovery reservoir.
- 3. Remove the fan shrouds eight attaching bolts, lift the shroud back and drape it over the fan.

- 4. Loosen the upper radiator hose clamp, and remove the hose from the radiator.
- 5. Remove the two radiator attaching bolts from the side mounts, and remove the rubber insulators from the mounting pads.
- Remove the upper radiator support by removing four attaching bolts, and remove the radiator by lifting up and out.
- Lift the fan shroud off the fan and remove from the vehicle.



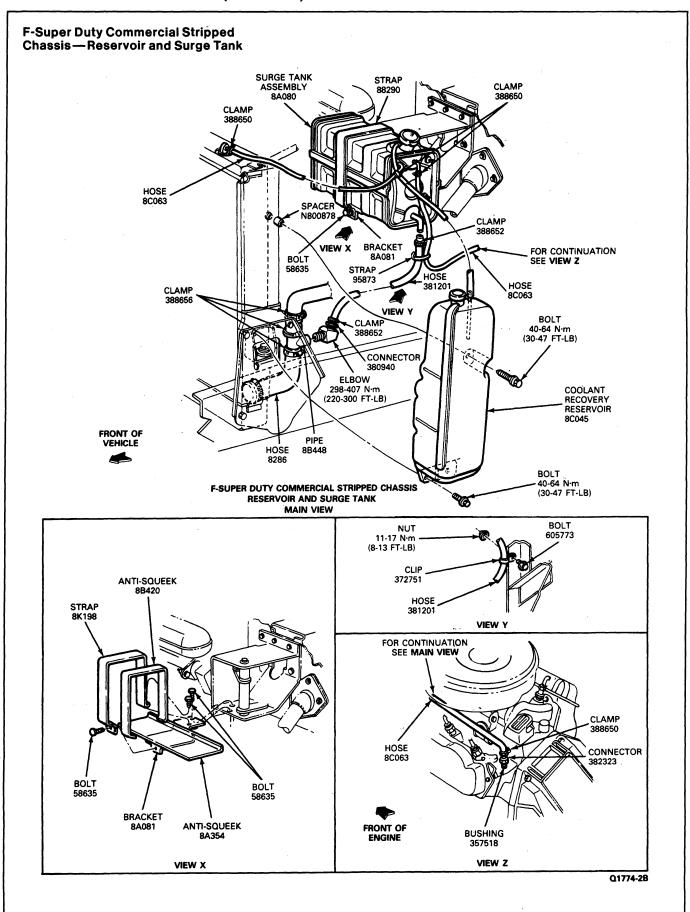
#### Installation

- Position the fan shroud on the fan.
- Install the radiator from the bottom into the upper radiator insulators, then install the rubber insulators and the mounting bolts. Tighten the bolts to 102-142 N·m (75-105 ft-lb).
- 3. Install the upper and lower hoses and tighten the hose clamps.
- 4. Install the fan shroud and tighten the eight shroud bolts.
- Install the overflow hose to the coolant recovery bottle.

| WARNING: DO          | NOT STAND IN LINE WITH OR |
|----------------------|---------------------------|
| <b>NEAR THE RA</b>   | DIATOR FAN WHEN THE       |
| <b>ENGINE IS RUI</b> | NNING.                    |

NOTE: A coolant mixture of 50 percent coolant concentrate and 50 percent water is recommended to maintain best overall performance. To avoid damaging the radiator the coolant concentrate should not exceed 60 percent.

 Install new 50/50 mixture of water and ethylene glycol and operate the engine for 15 minutes. Check the coolant level and bring it up to within 38mm (1-1/2 inches) of the radiator filler neck. Add two cooling system protection pellets. Part Number D9AZ-19558-A or equivalent.



#### SERVICE PROCEDURES

Copper/Brass Radiators

E-150-E-350 All Engines

F-250- F-450 7.3L Diesel Engine

#### **Radiator Core and Tank Service**

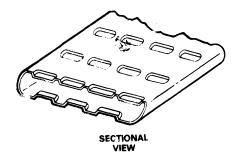
Conventional soft solder service methods should be used when repairing the copper/brass core.

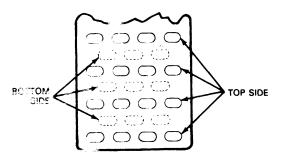
CAUTION: Only manufactured or natural gas torches should be used to perform radiator repairs. Do not use acetylene. No attempt should be made to repair a fractured radiator tank. It must be replaced. Tank repairs usually result in repeated failures due to flexing of the tank caused by pressure increase and decrease.

#### Cleaning and Inspection

Refer to Cleaning and Inspection in this Section for procedures

CAUTION: Do not rod out the copper/brass diesel radiator. The tubes have integral turbulators embossed into them and damage to the tubes will result.





VIEW SHOWING POSITIONS OF TURBULATORS ON BOTH SIDES OF TUBE

Q2168-1A

## Oil Cooler and Soldered Radiator Drain Cock

Replacement of the automatic transmission oil cooler or cadiator draincock in the radiator lower tank is askally performed by radiator specialty shops. However, the operation can be performed, providing proper equipment is available.

the draincock is soldered directly to the radiator lower tank.

Only manufactured or natural gas torches should be used to perform radiator repairs. Do not use acetylene.

No attempt should be made to repair a fractured radiator tank. Should a fractured tank be encountered, it must be replaced. Tank repairs usually result in repeat failures, due to the flexing of the tank caused by pressure increase and decrease.

#### Removal

- Drain the cooling system. To prevent coolant loss when draining radiator, slip a hose on the draincock and drain coolant into a clean container.
- 2. Remove the radiator from the vehicle as outlined.
- Thoroughly clean the radiator assembly internally and externally by submerging in a tank filled with a caustic solution. Then, using clean water, flush until the caustic solution is removed from all internal and external surfaces.

CAUTION: Care should be exercised during the disassembly and assembly solder operation of radiator components. Avoid excess heat concentration which could result in burning through the radiator sheet metal or loosening an adjoining soldered area.

- 4. Remove the radiator tank containing the damaged or leaking oil cooler. (Tank removal is not necessary for repair of draincock).
- 5. Melt the puddled solder from the oil cooler inlet and outlet fittings, or draincock. Remove the retaining rings from the oil cooler fittings.
- 6. Remove the oil cooler or draincock.
- 7. Clean the soldered surface areas and inspect and tin as necessary to ensure proper solder bonding.

#### Installation

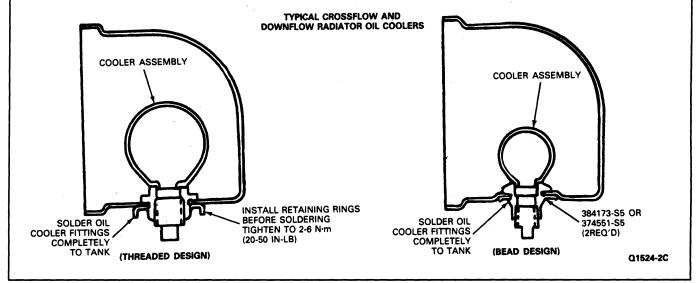
 Draincock: Position the replacement draincock or draincock boss in the tank opening and solder using the procedures for oil cooler.

NOTE: If one-piece draincock is not available, a threaded boss (8120) and draincock (8115) must be used. Solder the boss into the tank following the procedure for one-piece draincocks, then wrap the draincock threads with sealer tape and install the draincock in the boss. Tighten the draincock to 16-20 N·m (12-15 ft-lbs).

Oil Cooler: Install the replacement oil cooler assembly into the tank openings and secure cooler with new retaining rings. For bead design, push ring past fitting bead. Retaining ring tangs should point away from tank.

- Puddle-solder the oil cooler fitting completely to the tank.
- Seat the tank assembly in the header well and solder securely, completely filling the well. Use 40-60 solder with either zinc chloride 30 (BAUME) or 5-B NALCO flux.

- 4. Flush off all excess acid, internally and externally.
- Pressure test the radiator assembly to 132-144 kPa (19-20 psi) for leaks.
- 6. Paint as required.
- Install the radiator and fan shroud in the vehicle as outlined.
- NOTE: A mixture of 50 percent coolant concentrate and 50 percent water is recommended to maintain best overall performance. To avoid damaging the radiator, the coolant concentrate should not exceed 60 percent.
- Flush the cooling system and refill and bleed with the recommended mixture of all-season coolant. Refer to Cleaning and Inspection in this Section for procedure.



## Threaded Radiator Draincock Repair or Replace

- Drain the cooling system and remove the threaded draincock assembly from the radiator.
- Inspect the pipe threads on the draincock assembly and the threaded draincock boss in the radiator tank.
- If the boss threads are damaged, repair them with a 1/4 inch pipe tap. If the threads are damaged beyond repair, install a new draincock boss in the radiator tank.
- Apply a small amount of D8AZ-19554-A (ESG-M4G194-A) Pipe Sealant with TEFLON® or equivalent to threads and install the draincock. Tighten the draincock to 16-20 N·m (12-15 ft-lbs).
- Fill and bleed the cooling system and check for leaks. Refer to Cleaning and Inspection in this Section for procedure.

## **Aluminum Crossflow Radiators**

# F-150—F-Super Duty, Bronco—Gasoline Engines

## **CLEANING**

#### External

The aluminum core can be cleaned externally with a soft bristle brush, warm water and a mild household liquid detergent. Then, rinse with clear water.

If the radiator is equipped with an oil cooler, install steel or brass plugs in the oil cooler fittings before cleaning and keep them installed during the entire service operation.

#### Internal

NOTE: Do not use caustic cleaning solutions or copper / brass radiator cleaning agents on aluminum radiators. Internal cleaning of the aluminum tubes can be accomplished with sonic cleaning equipment, or, by removing one end tank to gain access to tubes. Then, clean the tubes with a mild household liquid detergent. Rinse the core with clean water when completed. Do not use a metal brush to clean an aluminum core. Use only horsehair, bristle or nylon brushes.

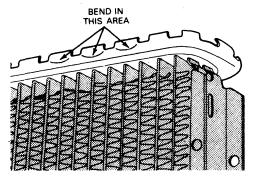
#### **Radiator Tank**

#### Removal

The radiator tanks are molded, glass-filled nylon and are attached to the core header by bending the header tabs over the edge of the tank.

When removing a nylon tank, a screwdriver or one of the various special tools available can be used to open the header tabs. Some of these tools, including a screwdriver, may cause a small section of the header side to bend with the tabs as they are opened. This slight deformation is permissible, provided the tabs are opened only enough for tank removal. The header sides will usually return to the normal position when the tabs are crimped during tank installation.

Procedures are given for tank removal using a screwdriver or a Borroughs Tool BT-8260. Follow the manufacturer's instructions for other radiator tab opening and closing tools.



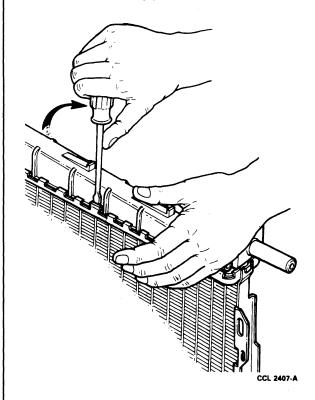
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## With Screwdriver

 Insert the end of a medium tip screwdriver between the end of the header tab and the tank. Then, press the screwdriver blade against the tank to bend (pry) the tab away from the tank edge. Repeat this procedure for each tab.

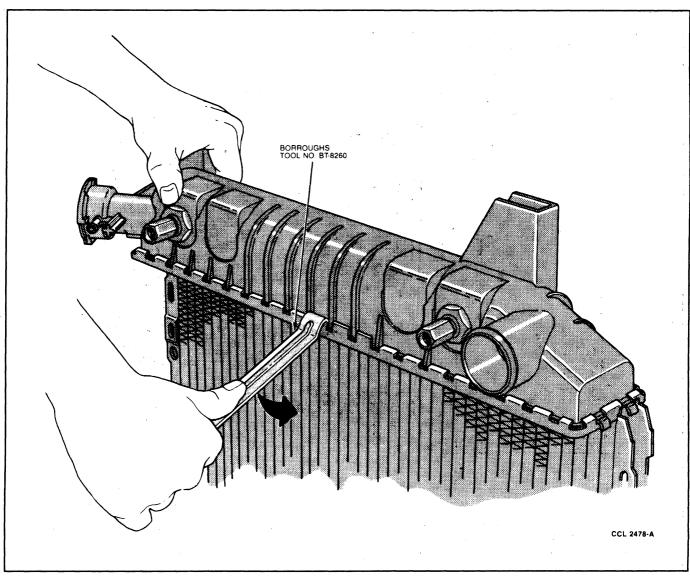
NOTE: Bend (open) the tabs only enough for tank removal.

- Lift the tank from the core header when all of the header tabs are bent away from the tank edge.
- 3. Remove the O-ring gasket from the header.



## With Borroughs Tool BT-8260

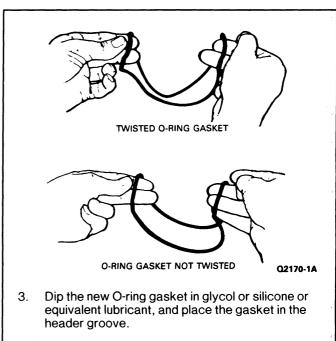
- Insert the end of Borroughs Tool BT-8260 between the end of the header tab and the tank. Then, push the tool handle down toward the core to bend the tab away from the radiator tank. Do not open the tabs more than is necessary for tank removal.
- Repeat Step 1 for each header tab. Then, lift the tank from the header.
- 3. Remove the O-ring gasket from the header.

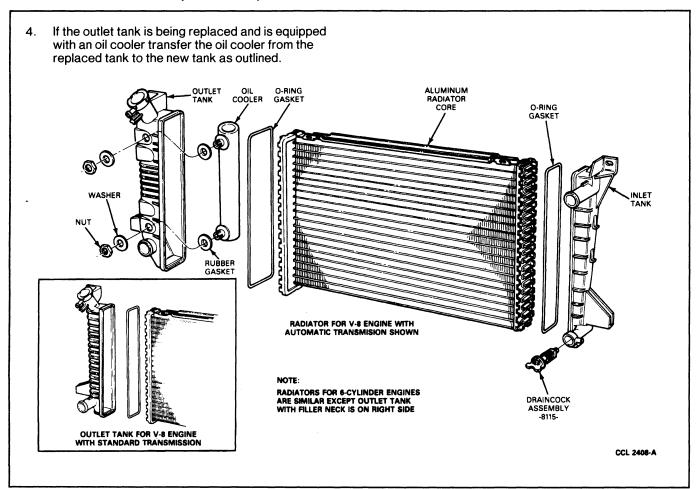


## Installation

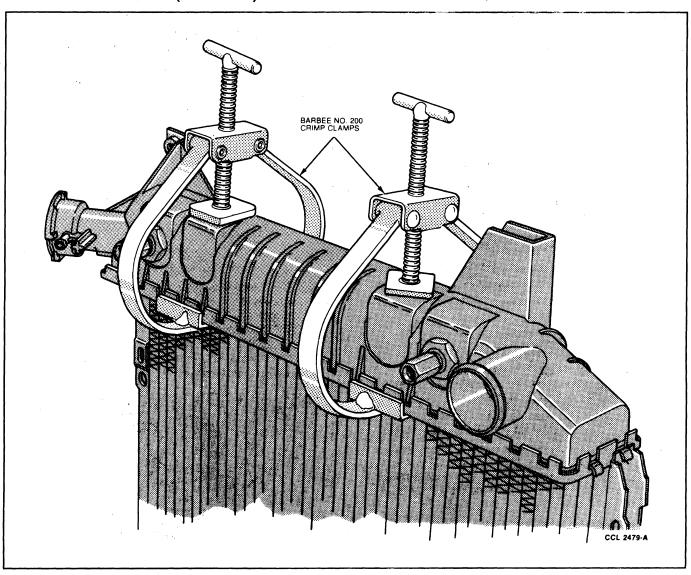
NOTE: If any header tabs are missing from an aluminum core, the core should be replaced.

- Inspect the seal surface of the radiator core header to ensure it is clean and free of foreign material or damage.
- 2. Check the new O-ring to ensure it is not twisted.

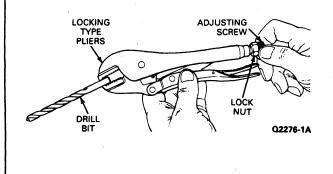


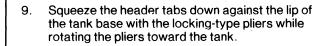


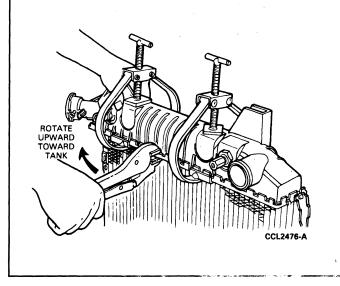
- Position the tank to the header using care not to scratch the tank sealing surfaces with the header tabs. Be sure the top and bottom of the tank is positioned properly with the other tank.
- 6. Clamp the tank in position on the header with two header clamps as shown. Tighten the header clamps to compress the O-ring gasket.



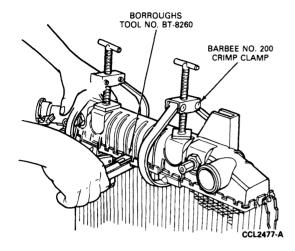
- 7. If locking-type pliers are used to squeeze the header tabs against the tank, install a hex nut on the pliers adjusting screw.
- 8. With the jaws of the locking-type pliers closed and locked, turn the adjusting screw to position the jaws against the shank of a 13/32-inch drill bit. Then, tighten the hex nut on the adjusting screw against the handle to lock the adjustment in place.





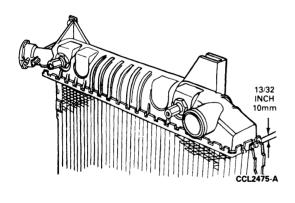


 If a special crimping tool is used follow the manufacturer's instructions.



NOTE: It is, however, important that the assembled height of the crimp be 10.3mm (13/32 inch) when measured from the bottom of the header to the top of the tab.

- 11. Remove the header clamps and squeeze the header tabs down that were behind the clamps.
- 12. Leak test the radiator at 145 kPa (21 psi). Most minor leaks at the header-to-tank seal can be corrected by again squeezing the header tabs down against the tank lip in the area of the indicated leak.



#### **Radiator Core Service**

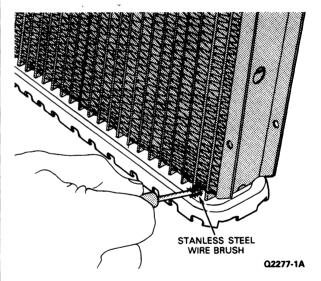
The only approved service method for the aluminum radiator core is using a two-part epoxy material. The materials and supplies necessary to service the aluminum core radiator are:

- EPOXI-PATCH KIT No. 6C Aluminum, Hysol Division of the Dexter Corporation, Olean, New York 14760.
- Sandpaper and/or emery paper—80 or 100 grit.
- Stainless steel wire brush No. 23151 or equivalent, Milwaukee Brush Manufacturing Co., Menomonee Falls, Wisconsin 53051.
- 375-watt heating lamp.
- Mixing card and spatulas.

#### Service Procedure

- 1. Clean and leak test core as outlined.
- Mark leak(s) and dry core with compressed air in area of leak(s).
- If leak is in fin area of core, spread fins away from leak before cleaning area.
- 4. Thoroughly clean the area around the leak with a stainless steel wire brush and, if necessary, emery paper to get to hard to reach areas. Use the brush on the epoxy as well as on the aluminum.

CAUTION: Do not use wire brushes that are not stainless steel.

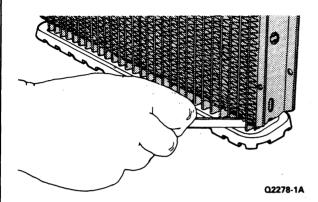


 Squeeze a bead (length) of Epoxi-Patch service material resin (Part A) on a clean, dry disposable flat mixing surface. Use uniform pressure to obtain an even bead.

WARNING: OBSERVE ALL CAUTIONS AND WARNINGS PRINTED ON THE SERVICE MATERIAL CONTAINERS.

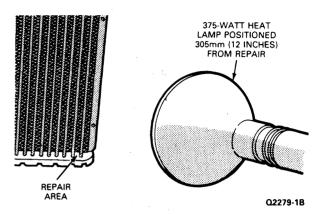
 Squeeze an equal bead (length) of Epoxi-Patch hardener (Part B) parallel to the Part A bead. Mix Parts A and B together.

7. If it is necessary to have the epoxy flow to obtain a satisfactory repair, warm the core around the leak with a 375-watt heat lamp. Then, apply the Epoxi-Patch material to the leak.

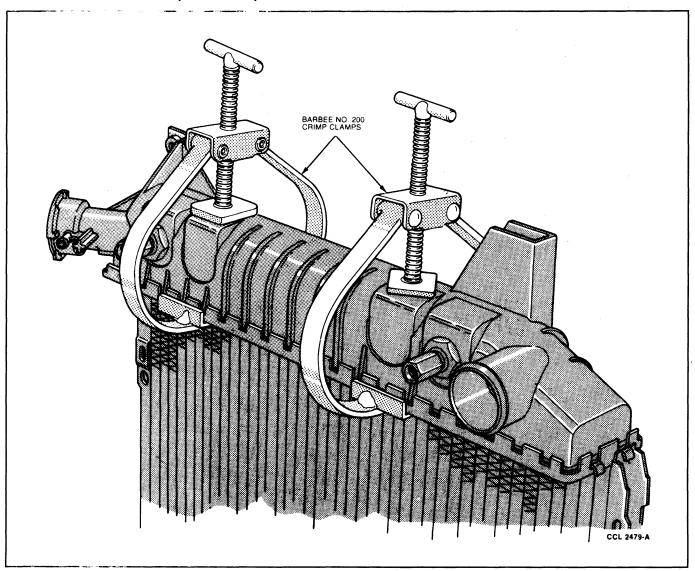


Position the 375 watt heat lamp 305mm (12 inches) from the service area and allow the epoxy to cure for two hours.

CAUTION: Do not position the heat lamp closer to the epoxy area than 305mm (12 inches). Do not use a heat gun or overheat the epoxy material.



- When the epoxy is cured, test the service area. If tank has been removed clamp it to the header with No. 200 crimp clamps or equivalent to leak test.
- 10. After a successful leak test, paint if required. Install the radiator tank as outlined.

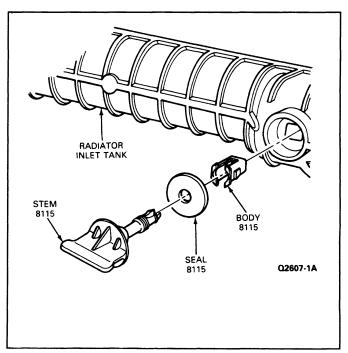


## **Draincock Replacement**

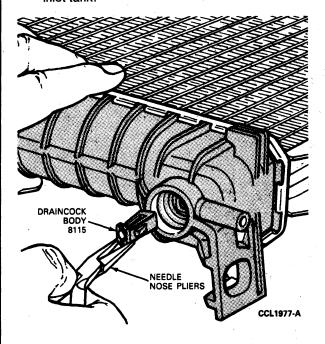
The draincock is located near the bottom of the inlet tank and can be replaced without removing the tank from the radiator. However, the radiator must be drained and should be removed from the vehicle for access to the draincock.

## Removal

 Turn the draincock stem counterclockwise to unscrew the stem and drain the radiator. After the radiator is drained, and when the stem is unscrewed to the end of the threads, pull the stem from the radiator tank and draincock body.

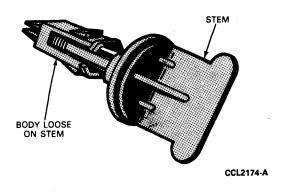


Remove the draincock body from the radiator tank by squeezing the sides together with a pair of needle nose pliers. Then, pull the body from the inlet tank.



#### Installation

- Check the draincock to be sure the body is installed loosely on the stem. If the stem is screwed into the body, the draincock cannot be installed into the tank opening.
- Push the loosely assembled draincock assembly body into the tank opening until it snaps into place.
- Tighten the drain cock stem by turning clockwise 3. to 2.0-2.7 N·m (18-25 lbs-in) torque.

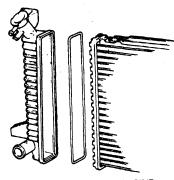


## Oil Cooler Transfer Or Replacement Removal

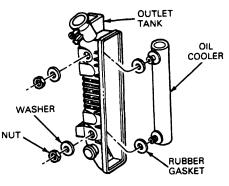
- Remove the outlet tank from the radiator as outlined.
- Remove the retaining nuts and washers from the oil cooler inlet and outlet connections. Then, lift the oil cooler from the radiator outlet tank.
- Remove the rubber gaskets from the oil cooler inlet and outlet connections if the oil cooler is to be reused.

#### Installation

- Install new rubber gaskets on the oil cooler inlet and outlet connections.
- Position the oil cooler to the radiator outlet tank and insert the inlet and outlet connections through the holes in the outlet tank.
- Install the flat washer and nut on each oil cooler connection to retain the oil cooler in the radiator outlet tank.
- Tighten the oil cooler retaining nuts to 12-15 N·m (9-11 ft-lb).
- Install the outlet tank on the radiator core header as outlined.



**OUTLET TANK FOR V-8 ENGINE** WITH STANDARD TRANSMISSION



NOTE: V8 RADIATOR SHOWN. I-6 RADIATOR HAS OIL COOLER AND FILLER **NECK IN RH TANK** 

O2608-1A

## **SPECIFICATIONS**

ENGINE COOLING SYSTEM REFILL CAPACITIES — F-150 THROUGH F-350, BRONCO, F-SUPER DUTY SERIES AND E-150 THROUGH E-350 — DIESEL

| Engine Truck Model/Type                               |   | Equipment  | Approving Spartly |            |             |
|---|---|--|-------------------|------------|-------------|
|   |   | Eduibiteit   | U.S. Quarte       | State Back | Litere      |
| 4.9L<br>(300 CID) F-150/350, F-Super<br>Duty & Bronco |   | Manual and Auto. Trans. — Standard   | .13               | 10         | 12          |
|   |   | Manual Trans. with A/C or Super Cool<br>Auto. Trans. with Super Cool or Standard       | 74.               | 112        | 13          |
|   |   | Manual Trans, with A/C and Super Cool Auto. Trans, with A/C and Super Cool or just A/C | i <b>5</b>        | 12: ">     | 14          |
| 5.0L F-150/250<br>(302 CID) Bronco<br>V-8             |   | Manual Trans. — Standard   | 13                | 10         | 12          |
|   |   | Manual and Auto. Trans. with A/C Auto. Trans. —<br>Standard                            | ~ 1 <b>4</b> .    | 4          | 13          |
|   |   | Manual and Auto. Trans. with Super Cool or Super Cool and A/C                          | <b>. 15</b>       | 12,        | 14          |
| 5.8L F-150/350<br>(351 CID) Bronco<br>V-8             | Manual Trans. — Standard  | 15   | 12                | 14         |             |
|   |   | Auto. Trans. — Standard or A/C, Manual Trans. with A/C                                 | 16                | . 18       | 15          |
|   |   | Manual and Auto. Trans. with Super Cool or Super Cool and A/C                          | 17 - 3            | 14         | 16          |
| 7.5L<br>(460 CID)<br>V-8                              | F-250/350, F-Super<br>Duty Chassis Cab<br>and Motor Home<br>Chassis Vehicles    | All options  | 18                | 15*        | 17          |
| 7.3L<br>Diesel  | F-250/350 and<br>F-Super Duty Chassis<br>Cab and Commercial<br>Stripped Chassis | All options  | 29①               | 23⊕        | 27 <b>⊙</b> |
|   | E-250/350   | All options  | 31①               | 25①        | <b>29</b> ① |

①Include 5 quarts (or equivalent liters or Imperial quarts) in reservoir bottle.

CQ2606-2C

## **SPECIFICATIONS (Continued)**

# ENGINE COOLING SYSTEM REFILL CAPACITIES — E-150 THROUGH E-350 GASOLINE

| Model                | Engine                           | Vehicle  | Approxim  | ate Capaci | ies (†2 |
|----------------------|----------------------------------|--|-----------|------------|---------|
| MOGE                 |                                  | Equipment  | U.S. Qts. | imp. Qts.  | Liters  |
| (300 CID) A          |                                  | Manual and<br>Auto. Trans.<br>Without Air<br>Conditioning                  | 15        | 12.5       | 14.2    |
|                      |                                  | Manual and<br>Auto. Trans.<br>With Air<br>Conditioning or<br>Super Cooling | 18        | 14.5       | 16      |
| E-250 (302 CID)      | Standard and<br>Air Conditioning | 17.5   | 14.0      | 16.6       |         |
|                      | V-8                              | Super Cooling  | 18.5      | 15.3       | 17.5    |
| E-250 (351 W CID) Co |                                  | Standard<br>Cooling  | 20        | 16         | 19      |
| E-350                | V-8:                             | Air Conditioning<br>or Super Cooling                                       | 21 🛰      | 16.8       | 20      |
| E-350                | 7.5L<br>(460 CID)<br>V-8         | All Options  | 28        | 23         | 26      |

①Add 1 quart (U.S.) for heater.

②Add 1.8 quarts (U.S.) for auxiliary heater (Econoline models).

CQ2735-1A

#### **TORQUE SPECIFICATION**

| Description   | N·m<br>(ft-lbs)    | Description   | N·m<br>(ft-lbs)    |
|---|--------------------|---|--------------------|
| Radiator to Body Sheet Metal E-150-E-350  | 14-20              | Radiator Support to Frame Insulator Bolts —   | 160-217            |
|   | (10-15)            | F-Super Duty Stripped Chassis   | (118-160)          |
| Radiator Hose Clamp Double Wire Clamp Bronco,                                       | 2.26-3.39          | Fan to Clutch, Fan/Clutch Assembly to Water Pump (All Engines Except 7.3L Diesel)       | 17-24              |
| F-150-F-350 and F-Super Duty, E-150-E-350   | (20-30 in-lbs.)    |   | (12-18)            |
| Radiator Hose Clamps Tangential Screw   | 2.8-3.9            | Shroud to Radiator — F-150-F-350,   | 7-10               |
| F-150-F-350, F-Super Duty and Bronco  | (25-35 in-lbs.)    | F-Super Duty and Bronco   | (4-6)              |
| Thermostat Housing 4.9L (300 CID) Six   | 17-20              | Shroud to Radiator —  | 2.7-5.4            |
|   | (12-15)            | F-Super Duty  | (24-48 in-lbs.)    |
| Thermostat Housing V-8 Engines except 7.5L (460 CID)                                | 17-24<br>(12-18)   | Water Filter Hose Clip to Air Inlet Housing 3/8-16                                      | 28-33<br>(20-25)   |
| Thermostat Housing 7.5L (460 CID)   | 32-37              | Water Filter Hose Clip to Engine Idler Gear   | 40-48              |
|   | (23-28)            | Cover 3/8-16  | (29-36)            |
| Radiator Top Brackets to Radiator Support   | 11-14              | Transmission Oil Line Fitting to Radiator —   | 24-31              |
| F-150-F-350, F-Super Duty and Bronco  | (8-11)             | F-150-F-350, F-Super Duty and Bronco  | (18-23)            |
| Radiator Top Brackets to Radiator Support —   | 2.7-5.4            | Transmission Oil Line Nut to Fitting on Radiator — F-150-F-350, F-Super Duty and Bronco | 17-24              |
| F-Super Duty Stripped Chassis — F53   | (24-48 in-lbs)     |   | (12-18)            |
| Fan/Clutch Assembly to Water Pump — 4.9L  | 41-136<br>(30-100) | Fan/Clutch Assembly to Water Pump — 7.3L Diesel   | 54-163<br>(40-120) |
| Radiator Support to Frame Insulator Bolts —<br>F-150-F-350, F-Super Duty and Bronco | 41-47<br>(30-35)   | ·   |                    |

## COOLING SYSTEM PRESSURES (PSI)

|   |   | Operating<br>Pressure | Min. Test<br>Pressure |
|---|---|-----------------------|-----------------------|
| ſ | F-150-F-350, F-Super Duty, Bronco, E-150-E350 | 13                    | 10                    |

CQ1084-2R

## SPECIAL SERVICE TOOLS AND EQUIPMENT

• No. 200 Crimp Clamp:

The Barbee Company

P.O. Box 323

Louisville, Kentucky 40201.

• No. 23151 Stainless Steel Wire Brush:

The Milwaukee Brush Manufacturing Co.

P.O. Box 830

Menomonee Falls, Wisconsin 53051.

- Heat Lamp and Socket: 375 Watt.
- Epoxi-Patch Kit No. 6C Aluminum:

Hysol Division of the Dexter Corporation

Olean, New York 14760.

 Tool BT8260 and 8260-A Radiator Core Remover and Replacer:

Borroughs Tool and Equipment Corporation 2429 North Burdick St.

| yes temes a con- | The state of the s |
|------------------|--|
| Tool Mimber      |  |
| T83T-6312-A      | Fen Chart Pality Noticer — 7.31, Diesel-   |
| T83T-6312-B      | Fee Clieb, New Months - 7.3L, Dissel   |
| T84T-6812-C      | The Cause (Stay 1984) - 431. Engine  |
| T84T-6312-D      | Fan (Sach Büt Braich — 4.8. Engine   |
| T85T-18639-AH    | House Your Majories Tool   |
| OTUNDA EQUIPMENT |  |
| Model            | Diedlution   |
| 021-00012        | Cooling Station Presidentection Kit  |
| 021-00046        | Aria-Francis Touter  |
|                  | <b>CO1443-1</b> L  |

# SECTION 03-04 Fuel System General Service—Gasoline Engines

| SUBJECT                                      |          | SUBJECT               | PAGE    |
|--|----------|-----------------------|---------|
| CLEANING AND INSPECTION                      |          | DESCRIPTION           |         |
| CLEANING AND INSPECTION  Electric Fuel Pumps | .03-04-2 | Identification Number |         |
| Electronic Fuel Injection — Air Bypass       |          | SPECIFICATIONS        | 03-04-2 |
| Valve  | .03-04-1 | VEHICLE APPLICATION   | 03-04-1 |
| Throttle Body                                | .03-04-2 |                       | i ·     |

## **VEHICLE APPLICATION**

All E-150—E-350, F-150—F-350, F-Super Duty and Bronco Vehicles

#### DESCRIPTION

All engines incorporate a closed-type positive crankcase ventilation system and an exhaust emission system to control engine emissions within Government specifications.

Additional engine performance checks are required to keep the exhaust emissions at the specified minimum pollutant level. Refer to the Pre-Delivery, Maintenance and Lubrication Shop Manual for these performance checks and the recommended intervals.

This section covers the cleaning and inspection procedures.

For fuel system component removal, disassembly, assembly, installation and major repair procedures, refer to the pertinent section of this group.

On all engines requiring unleaded fuel, the "Unleaded Fuel Only" nomenclature must appear:

- Near the fuel filler opening.
- On the instrument cluster.

#### **Identification Number**

For EFI applications, refer to the EFI Section of this manual.

#### **CLEANING AND INSPECTION**

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED RESULTING IN POSSIBLE HUMAN INJURY.

## Electronic Fuel Injection—Air Bypass Valve

Remove the air bypass valve from the throttle body. Remove the electrical solenoid assembly from the mechanical portion of the air bypass valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up-Cleaner D9AZ-19579-AA (ESR-M14P9-A), or equivalent for 2 to 3 minutes maximum.

CAUTION: Do not exceed 3 minutes soak time, and do not use choke cleaner, as an internal O-ring may begin to deteriorate.

## **CLEANING AND INSPECTION (Continued)**

With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly using shop air. Reaction the air bypass valve to the throttle body, and reset idle to specification, if necessary.

## **Throttle Body**

Hard cold starting, stalling at idle or during deceleration, rough or rolling idle or hesitation during acceleration may be caused by sludge deposits on the throttle body plate and throttle body. The sludge deposits can reduce the EFI system intake of air flow at closed throttle position. Sludge build-up is caused by a combination of engine oil and combustion by-products that are transferred from the PCV and the EGR systems. This, along with the induction pulsations, cause sludge to collect on the throttle bore and plate.

To correct these conditions, clean the throttle plates and throttle body using the following service procedure.

NOTE: Use a wire stemmed horse hair, or nylon bottle brush 25.4-38mm (1-1/2 inch) thick. Always wear rubber gloves and safety goggles while performing this procedure.

1. Remove air duct to throttle body inlet.

- Start and run engine. Spray Galburetor June-Up Cleaner D9AZ-19578-AA (E-Sh-M-1489-A), or equivalent into threfile Body bore. Spray until the bore and throttle plate are met enough to pass cleaner through the air by these valve (if it is part of the assembly).
- 3. Turn engine off for 15 minutes to spak.
- After 15 minutes, soak a bottle brush with combustion chamber disaper. Use this brush to remove sludge build-up on the throughout ore and plate. Keep the throttle wide open what scrubbing.

NOTE: Some pressure while scrubbing is necessary on the brush, Repeat soaking and scrubbing for 2 to 3 minutes to make sure all the sludge at the throttle plate shaft is removed.

- Start engine and spray combustion chamber cleaner into throttle bore to weath off resigns. On assemblies with attached the bypass varies, spray some combustion chamber cleaner into varie inlet.
- Idle engine to dry out combustion chamber cleaner residue.
- 7. Reinstall air duct.

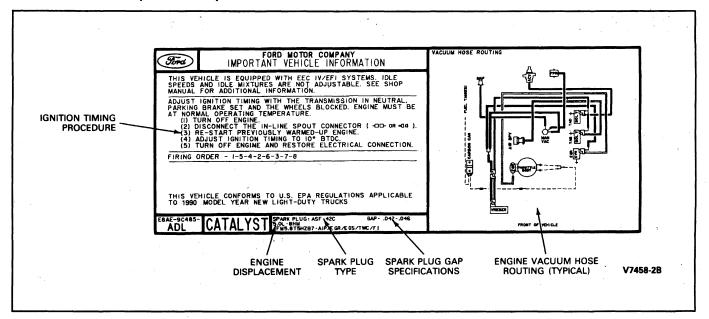
## **Electric Fuel Pumps**

Refer to Section 10-01A, Fuel Tank, Pump Lines and Filters—Gasoline Engines, for testing procedures.

## **SPECIFICATIONS**

Refer to the Technical Service Bulletin—Special Specifications Issues for the Vehicle Emission Control Information decal.

## **SPECIFICATIONS (Continued)**



# SECTION 03-04A Fuel Injection—5.0L and 5.8L Engines

| SUBJECT PAGE                          | SUBJECT  |
|---------------------------------------|--|
| CLEANING AND INSPECTION               | REMOVAL AND INSTALLATION (Count'd.)                              |
| Air Bypass Valve03-04A-5 COMPONENTS   | Air Intake Throttle Body03-04A-11 Fuel Charging Assembly03-04A-5 |
| Fuel Injectors03-04A-3                | Fuel Injector03-04A-16   |
| Fuel Pressure Regulator03-04A-4       | Fuel Pressure Regulator03-04A-15                                 |
| Fuel Supply Manifold Assembly03-04A-5 | Fuel Supply Manifold Assembly03-04A-13                           |
| Throttle Body Assembly                | Lower Intake Manifold  |
| DESCRIPTION AND OPERATION03-04A-1     | Throttle Position Sensor03-04A-12                                |
| OPERATION                             | Upper Intake Manifold and Throttle Body03-04A-6                  |
| Air Intake Manifold03-04A-2           | SPECIAL SERVICE TOOLS03-04A-17                                   |
| REMOVAL AND INSTALLATION              | SPECIFICATIONS03-04A-17  |
| Air Bypass Valve Assembly03-04A-12    |  |

## **VEHICLE APPLICATION**

Vehicles Equipped with 5.0L and 5.8L EFI V-8 Engine.

## **DESCRIPTION AND OPERATION**

The Electronic Fuel Injection system (EFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Injectors pulse to follow engine firing order in accordance with engine demand through injectors mounted on a tuned intake manifold.

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

An on-board vehicle electronic engine control (EEC-IV) computer accepts inputs from various engine sensors to compute the required fuel flow rate naccessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The computer then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

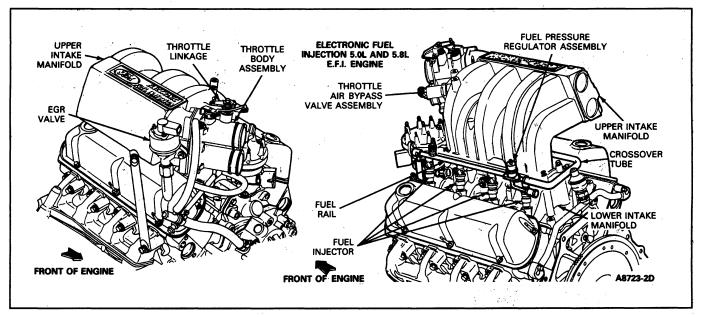
The EEC-IV engine control system also detarmines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains) and will also permit push-starting the vehicle should it become necessary (manual transmission only).

## **OPERATION**

The fuel delivery subsystem consists of a high-pressure in-tank mounted fuel pump and a fuel filter/reservoir delivering fuel from the fuel tank through a 20 micron fuel filter to a fuel charging manifold assembly.

The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

## **OPERATION (Continued)**

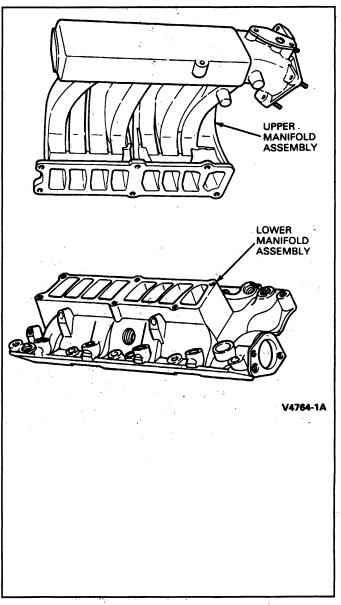


A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank through a fuel return line.

One group of four injectors is energized simultaneously, once every crankshaft revolution followed by the second group of injectors in the next crankshaft revolution. The period of time that the injectors are energized (injector "on time" or pulse width) is controlled by the vehicle's Electronic Engine Control (EEC-IV) computer. The EEC computer receives input from various engine sensors and uses this information to compute the required fuel flow rate necessary to compute the prescribed air / fuel ratio for the given engine operation. The computer determines the needed injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.

## Air Intake Manifold

The air intake manifold is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body assembly, fuel supply manifold and accelerator control bracketry and the EGR valve and supply tube. Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets in which the injectors are mounted are placed to direct the injector fuel spray immediately in front of each engine intake valve.



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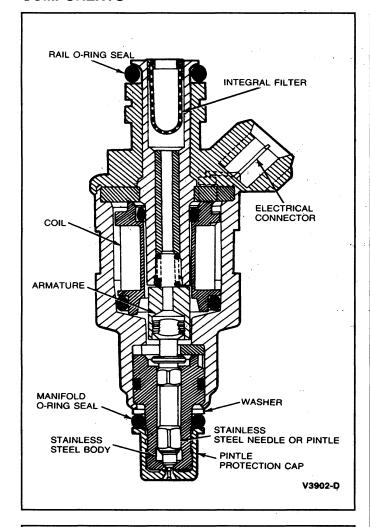
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#### COMPONENTS

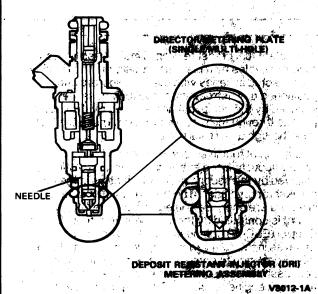


## **Fuel Injectors**

The eight fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The injectors are mounted in the lower intake manifold and are positioned so that their tips direct fuel just ahead of the engine intake valves. The injector bodies consist of a solenoid actuated pintle and needle valve assembly. An electrical control signal from the Electronic Engine Control unit activates the injector solenoid, causing the pintle to move inward off the seat, allowing fuel to flow. Since the injector flow orifice is fixed and the fuel pressure drop across the injector tip is constant, fuel flow to the engine is regulated by how long the solenoid is energized. Atomization is obtained by contouring the pintle at the point where the fuel separates.

Some vehicles equipped with 5.QL, 5.8L, 7.QL, and 7.5L EFI engines and E4QQ transmission may have Deposit Resistant Injectors (DFII) installed. The injector is designed to eliminate the figure such delivery concerns which occur with conventional multi-port fuel injectors when low grade, not designent fuels are used.

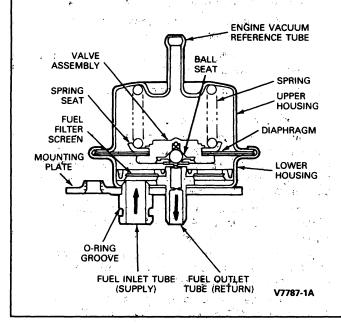
One type of DFR injector has no hards on the tip of the needle, such as a conventional injector has it meters fuel, instead, through four small boles in a metering plate on the end of the injector. As baken on tuel deposits coat the tip of the injector over time, they do not reduce the metering area of these small holes and the injectors maintain the proper fluit metering characteristics regardless of the quality of fuel being used. (They do not deteriorate feat as conventional injectors do.)



## **COMPONENTS (Continued)**

## Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel in excess of that used by the engine, is bypassed through the regulator and returns to the fuel tank.

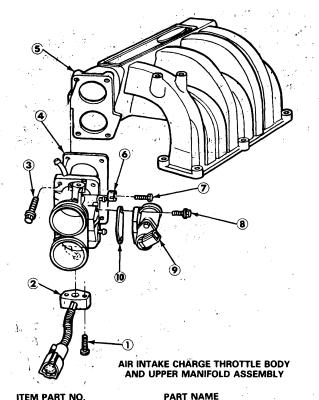


## **Throttle Body Assembly**

The throttle body assembly controls airflow to the engine through a double butterfly-type valve. The throttle position is controlled by a multiple-link, progressive opening, throttle linkage. The body is a single-piece die casting made of aluminum. It has a 🐠 dual bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle airflow as regulated by an air bypass valve assembly mounted directly to the throttle body. The valve assembly is an electro-mechanical device controlled by the EEC-IV computer. It incorporates a linear actuator which positions a variable area metering valve. Engine coolant is diverted through the throttle body mounting pad to improve cold weather operation.

Other features of the air throttle body assembly include:

- 1. A pre-set stop to locate the WOT position.
- 2. A throttle body mounted throttle position sensor.

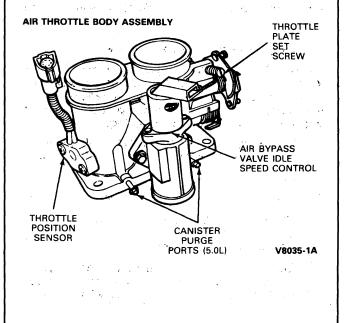


- 1. N803469-S100
- 9B989 56524-58
- 4. 9E936
- 5. 9424
- 6. 9C984
- 390667-S2
- 8. N605773-S100
- 9. 9F715 10. 9F670

#### PART NAME

- SCREW AND WASHER ASSEMBLY M4-x 22
- THROTTLE POSITION SENSOR BOLT -- 5/16-18 × 1.25
- GASKET AIR INTAKE CHARGE THROTTLE
- MANIFOLD INTAKE UPPER NUT THROTTLE PLATE SET SCREW
- LOCKING
- SCREW 10.32 BREAK-OFF HEAD BOLT M6  $\times$  20 AIR BYPASS VALVE ASSEMBLY
- GASKET AIR BYPASS

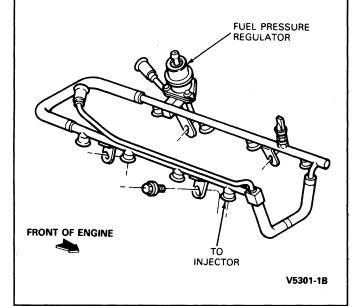
V4789-1F



## **COMPONENTS (Continued)**

## **Fuel Supply Manifold Assembly**

The fuel supply manifold assembly delivers high pressure fuel from the vehicle fuel supply line to the eight fuel injectors. The assembly consists of two banks of tubular fuel rails connected by two permanent crossover connections, eight injector connectors, a mounting flange to the fuel pressure regulator and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention. The fuel inlet and outlet connections have push connect fittings. The unit is serviced as an assembly only.



#### **CLEANING AND INSPECTION**

## Air Bypass Valve

CAUTION: Do not use the cleaning procedure on Nipondenso bypass valves, as valve damage may occur.

#### **Recommended Cleaning Procedure**

CAUTION: Do not clean black plastic bypass valves. Use only specified cleaner. Do not spray directly on throttle plate or use any type of scrubbing method. Do not run engines of vehicles with airflow meters during cleaning.

- Ensure bypass actuator is operating properly. Refer to Engine / Emissions Diagnosis\* manual.
- 2. Remove throttle inlet air tube.
- 3. Disconnect air bypass valve connector.
- Connect Rotunda Air Bypass Actuator 113-00009 and Injector Tester / Cleaner 113-00001 or equivalent.
- Start the actuator and then start the engine on vehicles that do not have airflow meters. Do not start engines of vehicles equipped with airflow meters.

- Spray Carburetor Cleaner D9AZ-19579-BA or equivalent into air bypass valve for five seconds while actuator is operating.
- Turn off the actuator and step engine. Allow solvent to soak for 15 minutes.
- Turn on actuator and start engine. Do not start engines on vehicles equipped with an airflew meter.
- On vehicles with airflow meters, spray carburetor cleaner into idle air bypass passage for no more than six seconds. On other vehicles, spray for up to one minute.
- 10. Turn off actuator and stop engine, if running.
- Install intake air tube. Start actuator and engine and run engine for one minute.
- 12. Disconnect actuator from bypass valve. Connect bypass valve electrical connector.
- 13. Start engine and check for proper operation.

## **Alternate Cleaning Procedure**

Remove the air bypass valve from the throttle body assembly. Remove the electrical solenoid assembly from the mechanical portion of the air bypass valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A), or equivalent for 2 to 3 minutes maximum.

CAUTION: Do not exceed 3 minutes soak time, and do not use choke cleaner as an internal O-ring may begin to deteriorate.

With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly with shop air.

## REMOVAL AND INSTALLATION

#### **Fuel Charging Assembly**

Throttle Body, Upper and Lower Manifolds

## Pre-Service Procedures

The fuel charging assembly consists of the air throttle body, and the upper and lower intake manifolds. Prior to service or removal of the fuel charging assembly, the following steps must be taken:

- 1. Open hood and install protective covers.
- Disconnect battery ground cable and secure it out of the way.
- Remove fuel cap and release tank pressure.

 Release pressure from fuel system. Refer to Section 24-50 for fuel system pressure relief procedures. A pressure relief (Schrader) valve on the fuel rail assembly is provided for this procedure.

#### **Post-Service Procedures**

After the service is complete and the fuel charging assembly is installed onto engine, the following steps must be taken:

- 1. Install fuel cap at tank.
- 2. Connect battery ground cable.
- 3. Add engine coolant, if necessary.
- Turn ignition switch ON/OFF several times without starting engine to check for fuel leaks.

NOTE: Check all connections at fuel rails, push connect fittings, etc.

CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

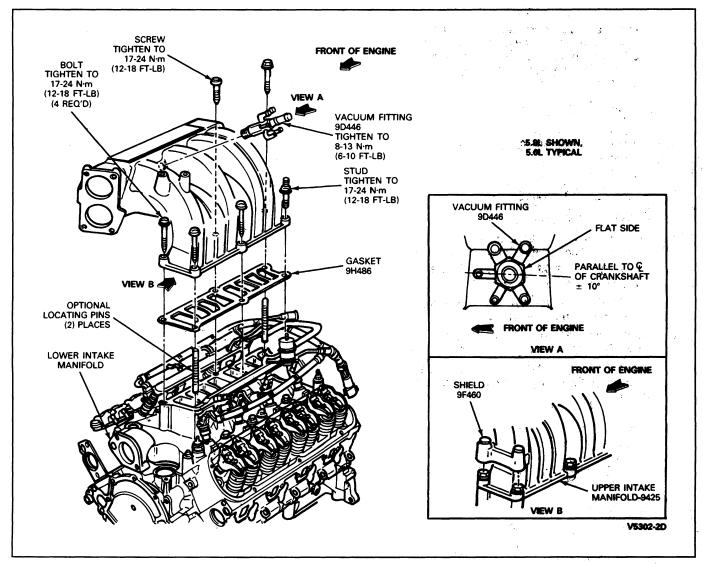
- Start engine and warm to operating temperature.
   Check for coolant leak if coolant was removed.
- Perform EEC-IV Self Test to check systems function. Refer to Engine / Emissions Diagnosis\* manual.

# Upper Intake Manifold and Throttle Body Removal

- Disconnect electrical connectors at air bypass valve, throttle position sensor and EGR position sensor.
- Disconnect throttle linkage at throttle ball.
   Disconnect AOD (5.0L only) transmission linkage from throttle body. Remove two bolts securing throttle linkage bracket to intake. Position bracket with cables out of way.

CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the stud and pry slowly. Pulling by hand may damage the cable.

- Disconnect upper intake manifold vacuum fitting connections by disconnecting all vacuum lines to vacuum tree, vacuum lines to EGR valve and vacuum line to fuel pressure regulator.
- 4. Disconnect PCV system by disconnecting hose from fitting on rear of upper manifold.
- 5. Remove canister purge line(s) from fitting(s) on throttle body.
- Disconnect water heater lines from the throttle body.
- Disconnect EGR tube from EGR valve by removing flange nut.
- 8. Remove bolt from upper intake support bracket to upper manifold.
- 9. Remove six upper intake manifold retaining bolts.
- Remove upper intake and throttle body as an assembly from lower intake manifold.



## Installation

- Clean and inspect the mounting faces of the lower and upper intake manifolds.
- Position new gasket on lower intake mounting face. The use of alignment studs may be helpful.
- Install upper intake manifold and throttle body assembly to lower manifold making sure gasket remains in place (if alignment studs are not used).
- Install six upper intake manifold retaining bolts and tighten to specification.
- Install upper intake support bracket to upper manifold attaching bolt.
- 6. Install EGR tube.
- Install canister purge lines to fittings on throttle body.
- 8. Connect water heater lines to the throttle body.
- Connect PCV hose to rear of upper manifold.

- Connect vacuum lines to vacuum tree, EGR valve and fuel pressure regulator.
- Position throttle linkage bracket with cables to upper intake manifold. Install two retaining bolts and tighten to specification. Connect throttle cable and transmission cable to throttle body.
- 12. Connect electrical connectors at air bypass valve, TP sensor and EGR position sensor.
  - NOTE: If lower intake manifold was removed, fill and bleed cooling system as outlined. Refer to Section 27-02, Cooling System General Service.

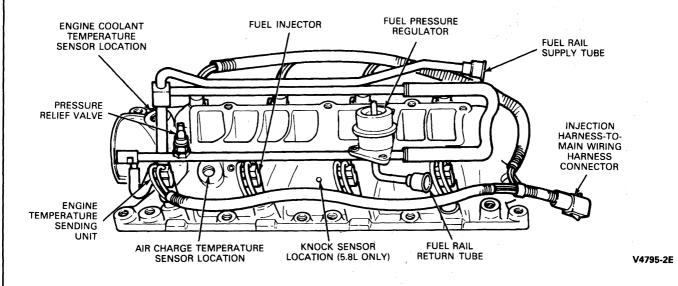
## Lower Intake Manifold

## Removal

- Remove upper intake manifold throttle body assembly and air cleaner assembly prior to lower intake manifold removal.
- 2. Drain cooling system.

- Remove distributor assembly, cap and wires. Mark position of distributor and rotor during removal so that they can be installed in their original position.
- Disconnect the electrical connections at the engine coolant temperature (ECT) sensor, engine temperature sending unit, air charge temperature (ACT) sensor, knock sensor (KS), electrical vacuum regulator (EVR) and Thermactor solenoids.
- 5. Disconnect the injector wiring harness from main harness assembly.

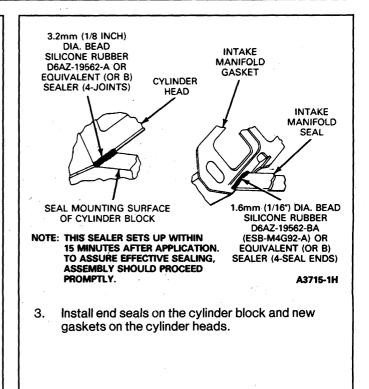
- Remove EGO ground wire from intake manifold stud.
  - NOTE: The plated stud and ground wire must be installed in the same position as when it was removed.
- Release fuel system pressure. Refer to Section 24-50, Fuel Tank and Lines and Fuel Evaporative Emission Control System.
- Disconnect fuel supply and return line retaining clips. Disconnect fuel supply and return lines from fuel rails, using Disconnect Tool D87L-9280-A and D87L-9280-B or equivalent. Refer to fuel supply manifold assembly.

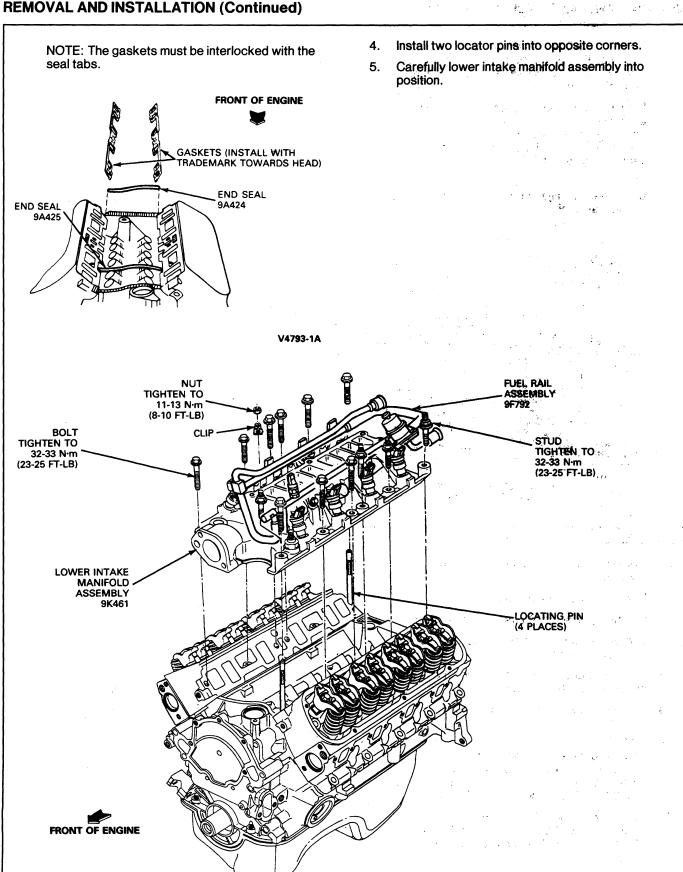


- Remove upper radiator hose from thermostat housing.
- 10. Remove water bypass hose.
- 11. Remove heater outlet hose at intake manifold.
- Remove nut securing coil bracket and move bracket out of way.
- Remove intake retaining bolts and studs, noting location of studs and bolts.
- 14. Remove lower intake manifold assembly.

#### Installation

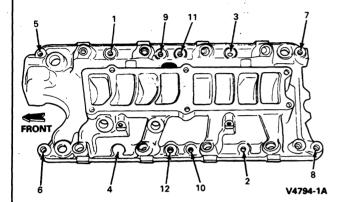
- Clean and inspect the mounting faces of the lower intake cylinder heads and cylinder block surfaces. Refer to Section 21-21, Engines—5.0L EFI (302 CID) V-8 and 5.8L (351 CID) W-V-8.
- Apply 1.6mm (1/16 inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A) or equivalent, sealer to the end seals (junction).



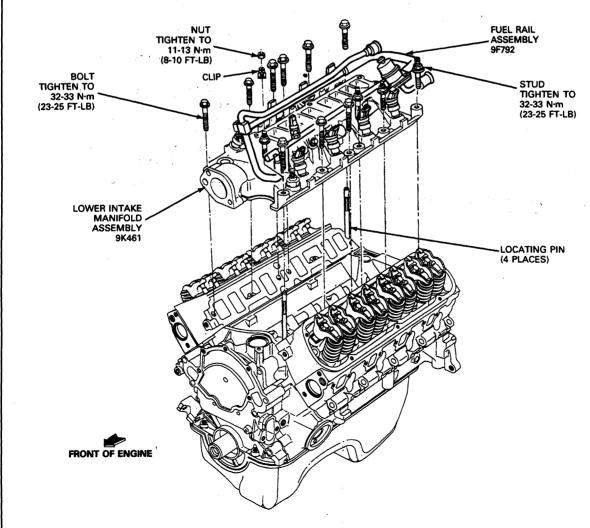


V4792-2D

- Install intake manifold bolts and studs. Tighten all bolts and studs in sequence to 30-43 N-m (22-32 ft-lb). Wait ten minutes then tighten all bolts and studs in sequence again to specification.
- Position coil bracket and hold in place while tightening nut.
- Install coil and solenoid bracket to intake manifold studs and exhaust manifold stud. Install retaining nuts and tighten to specification.



- 9. Install upper radiator hose and water bypass hose to thermostat housing.
- 10. Install heater outlet hose to intake manifold.
- Connect fuel supply and return lines to fuel rails.
   These are push connect fittings. Connect fuel line retaining clips.
- Connect the electrical connectors to engine coolant temperature (ECT) sensor, air charge temperature (ACT) sensor, engine temperature sender, knock sensor (KS, 5.0L), electrical vacuum regulator (EVR) and Thermactor solenoids.
- Install distributor assembly in the proper position as noted during removal. Install distributor cap and wires.
- Install upper intake manifold as outlined in this Section.
- 15. Fill and bleed the cooling system.

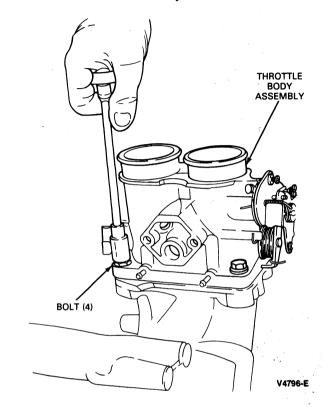


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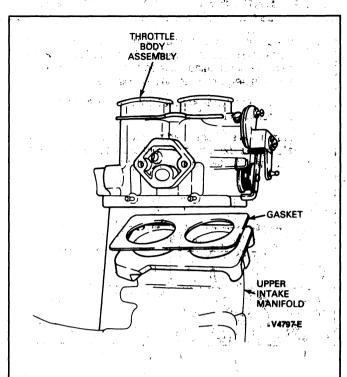
## **Air Intake Throttle Body**

## Removal

- Disconnect throttle position sensor and air bypass valve connectors.
- 2. Remove four throttle body bolts.



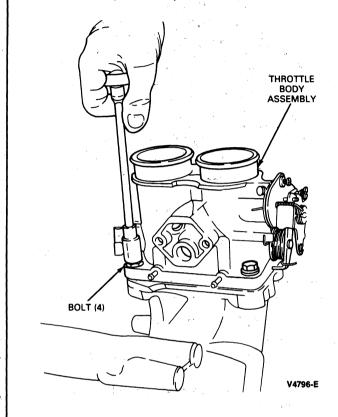
- 3. Carefully separate air throttle body from upper intake manifold.
- Remove and discard gasket between throttle body and upper intake manifold.



## Installation

- 1. Ensure that both throttle body and upper intake manifold gasket surfaces are clean.
  - NOTE: If scraping is necessary, be careful not to damage gasket surfaces of throttle body and upper manifold assemblies, or allow material to drop into manifold.
- 2. Install throttle body gasket on the four studs of the upper intake manifold.
- 3. Install throttle body to upper intake manifold.

 Secure throttle body assembly to upper intake manifold with four retaining bolts. Tighten to 16-24 N·m (12-18 ft-lb).



5. Connect air bypass valve and throttle position sensor electrical connectors.

## **Throttle Position Sensor**

#### Removal

- Disconnect throttle position sensor from wiring harness.
- Scribe a reference mark across the edge of the sensor and to the throttle body to ensure correct position during installation.
- 3. Remove two throttle position sensor retaining screws.
- 4. Remove throttle position sensor.

#### Installation

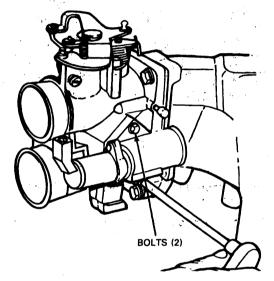
- Position the throttle position sensor so that the wiring harness is parallel to the venturi bores.
   Then, rotate throttle position sensor clockwise to align scribe marks.
- Secure sensor to throttle body assembly with two retaining screws. Tighten to 2.0-3.0 N·m (18-26.5 lb-in).

- 3. Connect electrical connector to harness.
- Adjust throttle position sensor as described in Section 3 of the Engine / Emissions Diagnosis\* manual.

## Air Bypass Valve Assembly

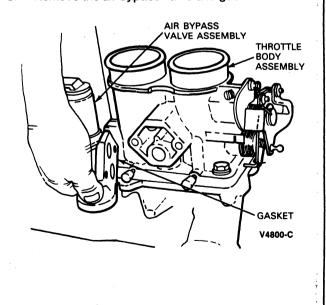
### Removal

- Disconnect the air bypass valve assembly connector from the wiring harness.
- 2. Remove the two air bypass valve retaining bolts.



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3. Remove the air bypass valve and gasket.



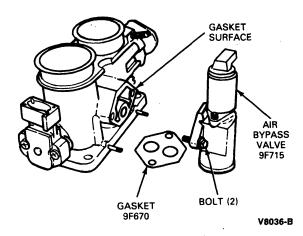
\*Can be purchased as a separate item.

#### Installation

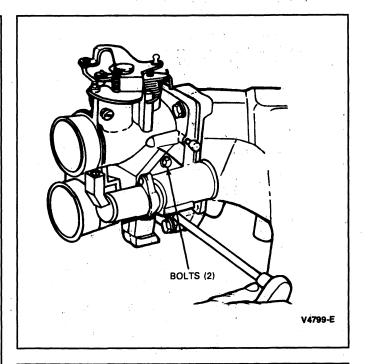
 Ensure that both throttle body and air bypass valve gasket surfaces are clean.

NOTE: If scraping is necessary, be careful not to damage air bypass valve or throttle body gasket surfaces, or drop material into throttle body.

Install gasket and air bypass valve on throttle body surfaces.



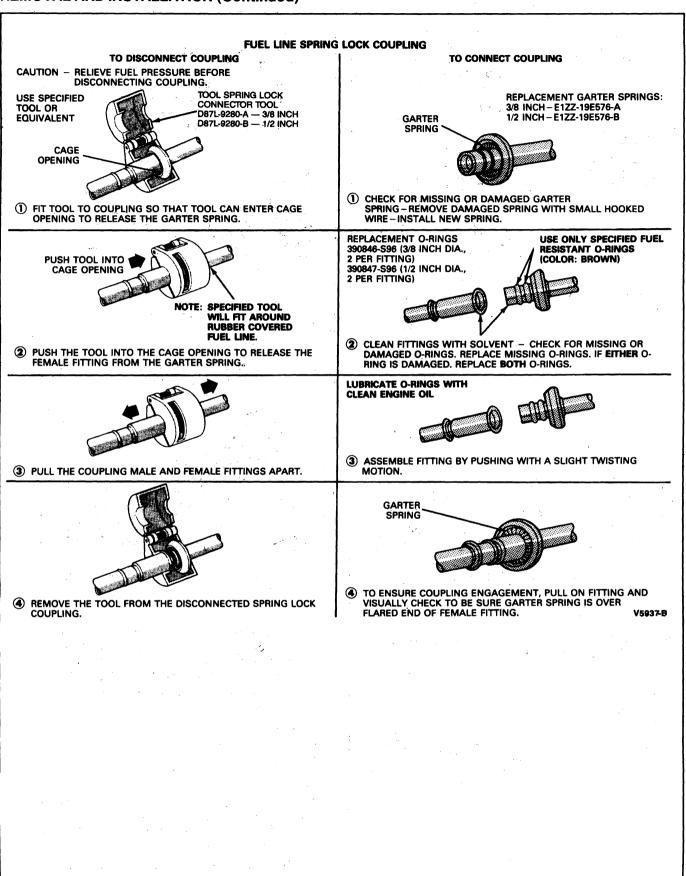
- 3. Install retaining screws. Tighten to 8-11 N·m (71-102 lb-in).
- Connect electrical connector for the air bypass valve.



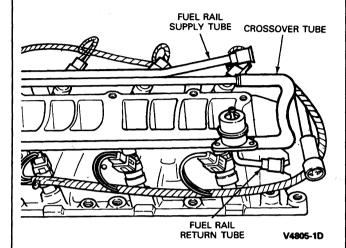
## Fuel Supply Manifold Assembly

#### Removal

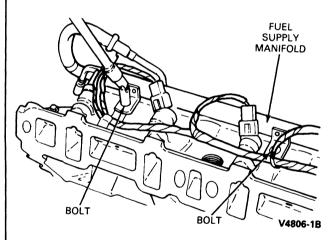
- Perform Steps 1 through 4 under Fuel Charging Assembly.
- 2. Remove upper manifold assembly as outlined in this Section.
- Relieve the fuel pressure. Refer to Section 24-50, Fuel Tank and Lines and Fuel Evaporative Emission Control System.
- Disconnect fuel supply and return line retaining clips.
- Using Spring Lock Coupling Disconnect Tool D87L-9280-A or D87L-9280-B or equivalent disconnect the fuel chassis inlet and outlet fuel hoses from the fuel supply manifold.



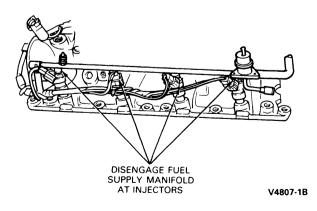
 Disconnect the fuel supply and return line connections at the fuel supply manifold. Refer to Section 24-50, Fuel Tanks and Lines, for Push Connect Fitting Removal procedures.



Remove four (two per group) fuel supply manifold retaining bolts.

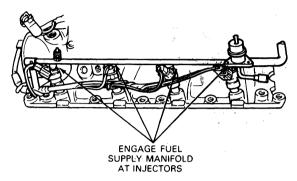


 Carefully disengage manifold from fuel injectors and remove manifold.



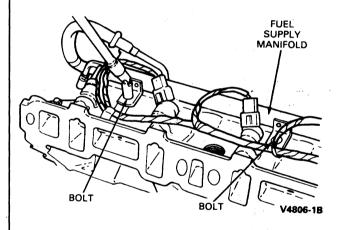
#### Installation

- Ensure injector caps are clean and free of contamination.
- Place the fuel injector fuel supply manifold over each of the injectors and seat injectors into fuel supply manifold. Make sure the injectors are well seated in the fuel manifold assembly.



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 Secure the fuel manifold assembly using four retaining bolts. Tighten to 20-30 N·m (15-22 ft-lb).



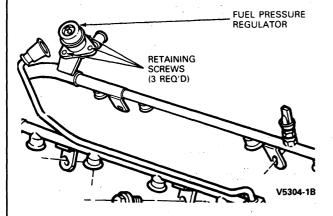
- Connect the fuel inlet and outlet lines at the fuel rail connections. Push in to connect. Refer to illustration under Fuel Supply Manifold Assembly, Removal. Connect fuel line retaining clips.
- Install upper intake manifold as outlined in this Section.

### Fuel Pressure Regulator

#### Removal

- Perform Steps 1 through 4 under Fuel Charging Assembly Pre-Service Procedures if removing fuel pressure regulator while fuel supply manifold is installed on engine.
- 2. Remove vacuum line at pressure regulator.
- Remove three Allen head retaining screws from regulator housing.

- Remove pressure regulator assembly, gasket and O-ring. Discard gasket and inspect O-ring for signs of cracks or deterioration.
- If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line gasket surfaces.



#### Installation

 Lubricate fuel pressure regulator O-ring with light oil ESE-M2C39-F or equivalent.

CAUTION: Never use silicone grease. It will clog the injectors.

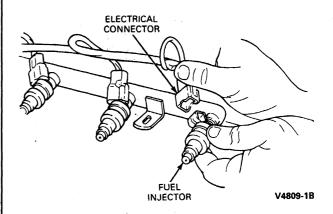
- Ensure gasket surfaces of fuel pressure regulator and fuel injector manifold are clean.
- 3. Install O-ring and new gasket on regulator.
- Install fuel pressure regulator on injector manifold. Tighten three retaining screws to 3.0-4.5 N·m (27-40 in-lb).
- 5. Install vacuum line to regulator.
- Perform Steps 1 through 5 under Fuel Charging Assembly Post Service Procedure.

#### **Fuel Injector**

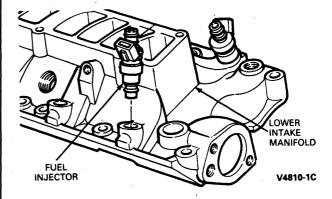
#### Removal

 Perform Steps 1 through 4 under Fuel Charging Assembly Pre-Service Procedures.

- 2. Carefully remove electrical harness connectors from individual injectors as required.
- 3. Remove upper intake manifold as outlined in this Section.

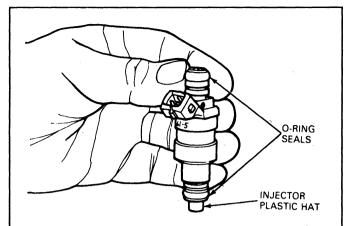


 Grasping injector body, pull up while gently rocking injector from side-to-side.



Inspect injector O-rings (two per injector) for signs of deterioration. Replace as required.

CAUTION: Do not attempt to clean the injector pintle or metering orifice with tools or brushes. Use Rotunda Injector Cleaner/Tester 113-00001 or equivalent.



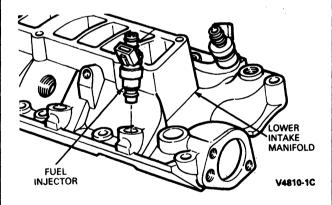
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#### Installation

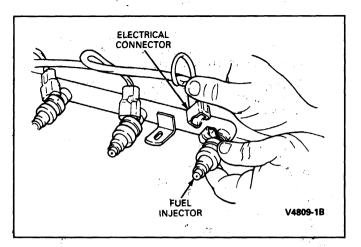
 Lubricate new O-rings with light grade oil ESE-M2C39-F or equivalent and install two on each injector.

CAUTION: Never use silicone grease. It will clog the injectors.

- Install injector(s) using light, twisting, pushing motion.
- 3. Install fuel supply manifold as outlined in this Section.



- 4. Install electrical harness connectors to injectors.
- Install upper intake manifold as outlined in this Section. Perform Steps 1 through 4 of Fuel Charging Assembly Pre-Service Procedures.



#### **SPECIFICATIONS**

| Description   | N●m       | Lb-Ft            |
|---|-----------|------------------|
| Lower Intake Manifold to Head                           | 30-43     | 22-32            |
| EGR Tube  | 33.8-47.5 | 25-35            |
| EGR Valve to Upper Intake Manifold                      | 17-25     | 13-19            |
| Cooling Manifold  | 4-5.6     | 35-50 ln-Lb      |
| Upper Intake Manifold to Lower Intake<br>Manifold Bolts | 16-24     | 12-18            |
| Throttle Body to Upper Intake Manifold                  | 16-24     | 12-18            |
| Air Bypass Valve to Throttle Body                       | 8-11      | 71-102<br>in-Lb  |
| Throttle Position Sensor to Throttle<br>Body            | 2.0-3.0   | 18-26.5<br>In-Lb |
| Fuel Pressure Regulator to Injector<br>Manifold         | 3-4.5     | 27-40 In-Lb      |
| Fuel Injector Manifold to Fuel charging Assembly        | 16-20     | 12-15            |
| Coil Bracket to Manifold Stud                           | 5.9-7.4   | \$2-65 in-Lb     |
| Throttle Cable Bracket to Manifold                      | a 11-13   | 8-10             |
| Air Door Bracket to A / C Cleaner                       | 7.9-11.2  | 70-100<br>In-Lb  |

#### **SPECIAL SERVICE TOOLS**

| Tool Number | Description                                   |
|-------------|---|
| D87L-9280-B | Spring Lock Coupling Disconnect Tool 1/2 inch |
| D87L-9280-A | Spring Lock Coupling Disconnect Tool 3/8 inch |
| T80L-9974-B | EFI Fuel Pressure Test Gauge                  |

| ROT | UNI | DAE | QUII | ME | NT |
|-----|-----|-----|------|----|----|
|     |     |     |      |    |    |

| Tool Number | Description               |
|-------------|---------------------------|
| 113-00001   | Injector Cleaner / Tester |

## SECTION 03-04B Fuel Injection—4.9L EFI Engine

| SUBJECT                       | PAGE                                    | SUBJECT   | PAGE      |
|-------------------------------|---|---|-----------|
| CLEANING AND INSPECTION       |   | REMOVAL AND INSTALLATION (Cont'd.)  |           |
| Air Bypass Valve              | 03-04B-5                                | Fuel Charging Assembly  | 03-04B-6  |
| COMPONENTS                    |   | Fuel Injection Wiring Harness   |           |
| Fuel Injectors                | 03-04B-4                                | Fuel Injector   | 03-04B-23 |
| Fuel Pressure Regulator       | 03-04B-4                                | Fuel Pressure Regulator   | 03-04B-21 |
| Fuel Supply Manifold Assembly | 03-04B-5                                | Fuel Supply Manifold Assembly   | 03-04B-19 |
| Throttle Body Assembly        | 03-04B-4                                | Pressure Relief Valve   | 03-04B-22 |
| DESCRIPTION                   |   | Throttle Position Sensor  | 03-04B-18 |
| OPERATION                     | 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - | Upper Intake Manifold and Throttle Bod  | ly        |
| Air Intake Manifold           | 03-04B-3                                | Assembly  |           |
| REMOVAL AND INSTALLATION      |   | SPECIAL SERVICE TOOLS   | 03-04B-24 |
| Air Bypass Valve Assembly     | 03-04B-18                               | SPECIFICATIONS  | 03-04B-24 |
| Air Intake Throttle Body      | 03-04B-16                               | VEHICLE APPLICATION   | 03-04B-1  |
| Assembly and Disassembly      |   | v of the state of |           |

#### **VEHICLE APPLICATION**

Vehicles Equipped with 4.9L EFI Engines.

#### **DESCRIPTION**

The Electronic Fuel Injection system (EFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Injectors pulse to follow engine firing order in accordance with engine demand through injectors mounted on a tuned intake manifold.

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

An onboard vehicle electronic engine control (EEC-IV) computer accepts inputs from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The computer then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

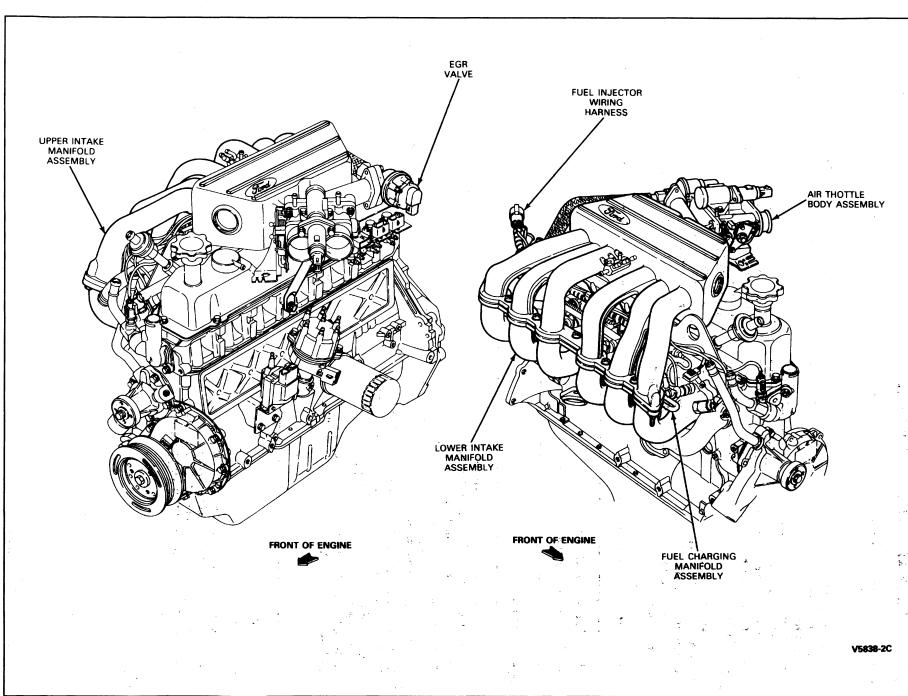
The EEC-IV engine control system also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains) and will also permit push-starting the vehicle should it become necessary (manual transmission only).

#### **OPERATION**

The fuel delivery subsystem consists of a high-pressure in-tank mounted fuel pump and a fuel filter / reservoir delivering fuel from the fuel tank through a 20 micron fuel filter to a fuel charging manifold assembly.

The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

**OPERATION (Continued)** 



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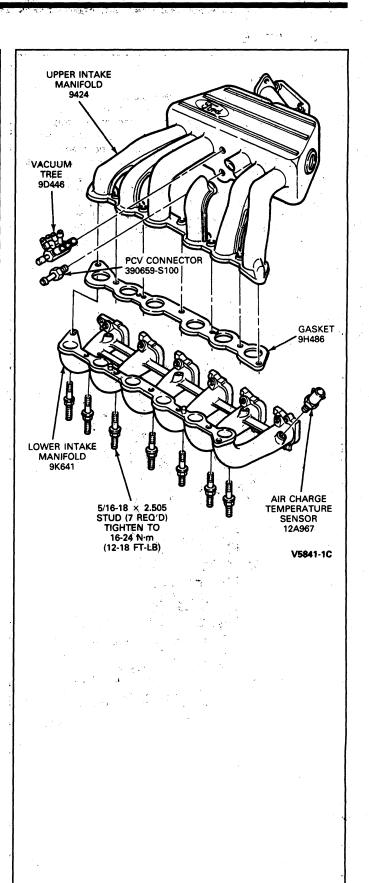
#### **OPERATION (Continued)**

A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank through a fuel return line.

The injectors are energized in two banks of three injectors, 1-3-5 in one bank and 2-4-6 in the other, with one bank energized every crankshaft revolution. The period of time that the injectors are energized (injector 'on time' or pulse width) is controlled by the vehicle's electronic engine control (EEC-IV) computer. Input from various engine sensors is used to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio for the given engine operation. The computer determines the needed injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.

#### Air Intake Manifold

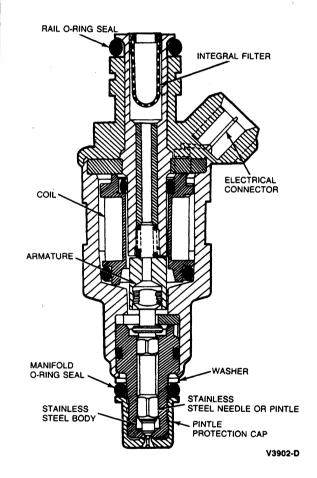
The air intake manifold is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throftle body assembly, fuel supply manifold and accelerator control bracketry and the EGR valve and supply tube. Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets in which the injectors are mounted are placed to direct the injector fuel spray immediately in front of each engine intake valve.



#### **COMPONENTS**

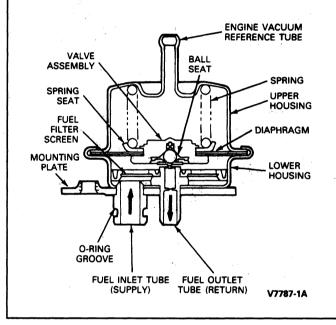
#### **Fuel Injectors**

The fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The EFI injectors are mounted in the lower intake manifold and are positioned so that their tips are directing fuel just before the engine intake valves. The valve body consists of a solenoid actuated valve assembly, therefore, fuel flow to the engine is regulated only by how long the solenoid is energized. An electrical signal from the EEC unit activates the solenoid, causing the pintle to move inward, off the seat, allowing the fuel to flow through the orifice. Atomization of the fuel is obtained by contouring the pintle at the point where the fuel separates.



#### **Fuel Pressure Regulator**

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel, in excess of that used by the engine, is bypassed through the regulator and returns to the fuel tank.



#### **Throttle Body Assembly**

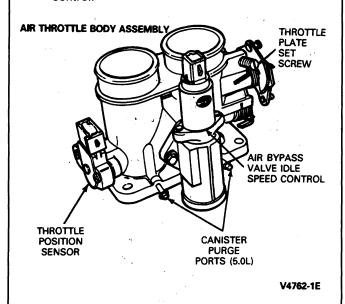
The throttle body assembly controls airflow to the engine through a double butterfly-type valve. The throttle position is controlled by multiple-link, progressive opening, throttle linkage. The body is a single-piece die casting made of aluminum. It has a dual bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle airflow as regulated by an air bypass valve assembly mounted directly to the throttle body. The valve assembly is an electro-mechanical device controlled by the EEC-IV computer. It incorporates a linear actuator which positions a variable area metering valve. Engine coolant is diverted through the throttle body mounting pad to improve cold weather operation.

Other features of the air throttle body assembly include:

- A pre-set stop to locate the WOT position.
- 2. A throttle body-mounted throttle position sensor.

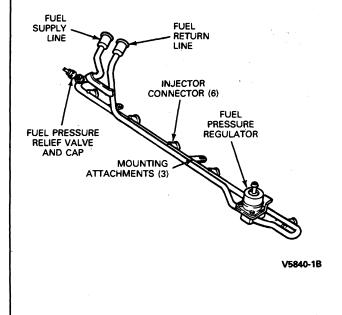
#### **COMPONENTS (Continued)**

Canister purge ports (2) for evaporative emission control.



#### **Fuel Supply Manifold Assembly**

The fuel supply manifold assembly delivers high-pressure fuel from the vehicle fuel supply line to the six fuel injectors. The assembly consists of a preformed tube for fuel supply and one for fuel return. The fuel manifold assembly has six injector connectors, a mounting flange for the fuel pressure regulator, and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention. The manifold also is equipped with a fuel pressure relief valve on the fuel supply tube.



#### CLEANING AND INSPECTION

#### Air Bypass Valve

CAUTION: Do not use the cleaning procedure on Nipondenso bypass valves, as valve damage may occur.

#### **Recommended Cleaning Procedure**

CAUTION: Do not clean black plastic bypass valves. Use only specified cleaner. Do not spray directly on throttle plate or use any type of scrubbing method. Do not run engines of vehicles with airflow meters during cleaning.

- Ensure bypass actuator is operating properly. Refer to Engine / Emissions Diagnosis\* manual.
- 2. Remove throttle inlet air tube.
- 3. Disconnect air bypass valve connector.
- Connect Rotunda Air Bypass Actuator 113-00009 and Injector Tester / Cleaner 113-00001 or equivalent.
- Start the actuator and then start the engine on vehicles that **do not** have airflow meters. **Do not** start engines of vehicles equipped with airflow meters.
- Spray Carburetor Cleaner D9AZ-19579-BA or equivalent into air bypass valve for five seconds while actuator is operating.
- Turn off the actuator and stop engine. Allow solvent to soak for 15 minutes.
- Turn on actuator and start engine. Do not start engines on vehicles equipped with an airflow meter.
- On vehicles with airflow meters, spray carburetor cleaner into idle air bypass passage for no more than six seconds. On other vehicles, spray for up to one minute.
- 10. Turn off actuator and stop engine, if running.
- Install intake air tube. Start actuator and engine and run engine for one minute.
- 12. Disconnect actuator from bypass valve. Connect bypass valve electrical connector.
- 13. Start engine and check for proper operation.

#### **Alternate Cleaning Procedure**

Remove the air bypass valve from the throttle body assembly. Remove the electrical solenoid assembly from the mechanical portion of the air bypass valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A), or equivalent for 2 to 3 minutes maximum.

CAUTION: Do not exceed 3 minutes soak time, and do not use choke cleaner as an internal O-ring may begin to deteriorate.

#### **CLEANING AND INSPECTION (Continued)**

With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly using shop air.

#### REMOVAL AND INSTALLATION

#### Fuel Charging Assembly Pre-Service Procedures

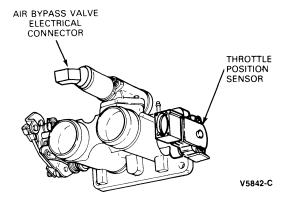
NOTE: If subassemblies are to be serviced and/or removed with the fuel charging assembly mounted on the engine, the following steps must be taken:

- Open hood and install protective covers.
- 2. Ensure ignition is in OFF position.
- Disconnect battery ground cable and secure it out of the way.
- 4. Remove fuel filler cap to relieve fuel tank pressure.
- 5. Release pressure from fuel system at the fuel pressure relief valve using EFI Pressure Gauge T80L-9974-B or equivalent. The fuel pressure relief valve is located on the fuel line in the upper RH corner of the engine compartment. To gain access to the fuel pressure relief valve, the valve cap must first be removed.

NOTE: Not all assemblies may be serviceable while on the engine. In some cases, removal of the fuel charging assembly may ease service of the various subassemblies. To remove the entire fuel charging assembly, the following procedure should be performed.

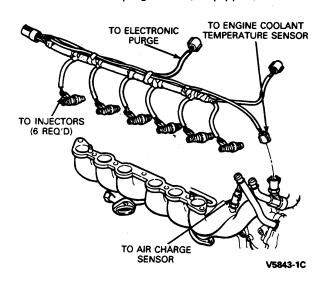
#### Removal

- Disconnect electrical connectors at:
  - a. Throttle position sensor.
  - b. Air bypass valve.

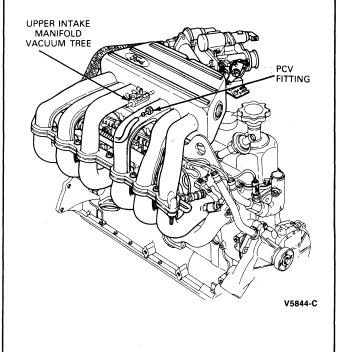


EVP sensor, located on the EGR valve.

- Injector wiring harness to main engine harness.
- e. Electronic purge valve (if equipped).



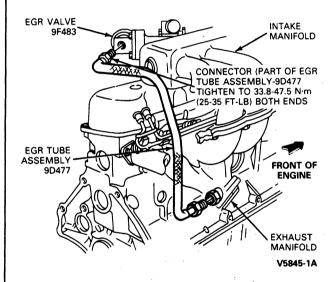
- 2. Disconnect the following vacuum connections:
  - a. Vacuum line at the EGR valve.
  - Vacuum lines at the thermactor air bypass valve.
  - Sealed Housing Evaporative Determination System (S.H.E.D.) evap lines to the throttle body.
  - d. Vacuum line at the fuel pressure regulator.
  - e. Vacuum lines to the upper intake manifold vacuum tree. Labeling the hose locations with tape is recommended to aid installation.



- 3. Disconnect the PCV hose from the fitting located on the underside of the upper intake manifold.
- Remove the throttle linkage shield and disconnect the throttle linkage and speed control cables. Unbolt the accelerator cable from the bracket and position the cable away from the engine.

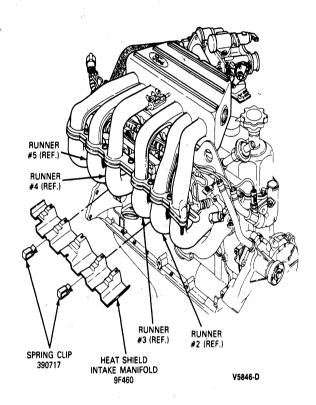
CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the ball stud to pry off. Removing by hand may damage the cable.

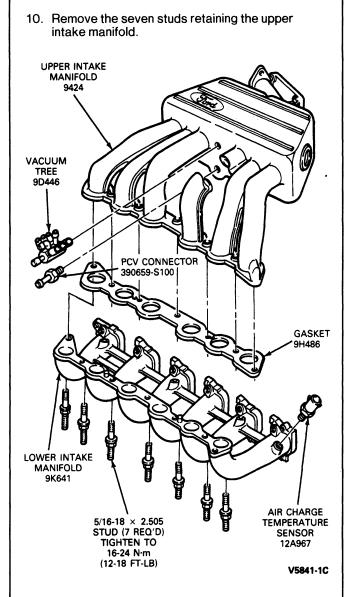
- 5. Disconnect the air inlet hoses from the throttle body.
- Disconnect the EGR tube from the EGR valve and the rear exhaust manifold. Remove the tube from the engine.



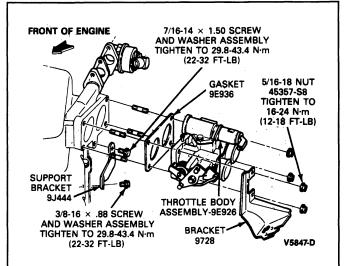
 Remove the Thermactor tube assembly from the lower intake manifold by removing the two nuts retaining the tube. Remove the nut which attaches the Thermactor bypass valve bracket to the lower intake manifold.

- For E-series applications only, remove the nut which attaches the transmission fill tube. Then remove the tube bracket off the intake manifold stud.
- Remove the two spring clips attaching the injector heat shield to the lower intake manifold and the exhaust manifolds. Remove the shield from between the lower intake manifold and the exhaust manifolds.

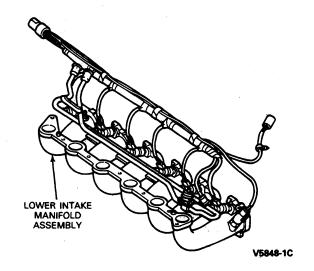




 Remove the screw and washer assembly attaching the upper intake manifold support bracket to the upper intake manifold.



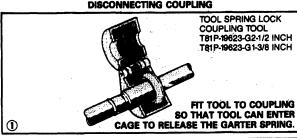
- Remove the upper intake manifold and throttle body assembly from the lower intake manifold.
- Move the vacuum harness away from the lower intake manifold.



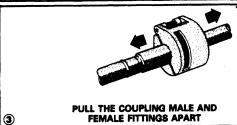
14. Disconnect fuel line retaining clips.

15. Disconnect the fuel supply and fuel return lines using Spring Lock Coupling Disconnect Tool D87L-9280-A or D87L-9280-B or equivalent.

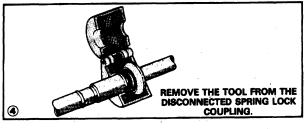
#### TO DISCONNECT COUPLING RELIEVE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING COUPLING WARNING -





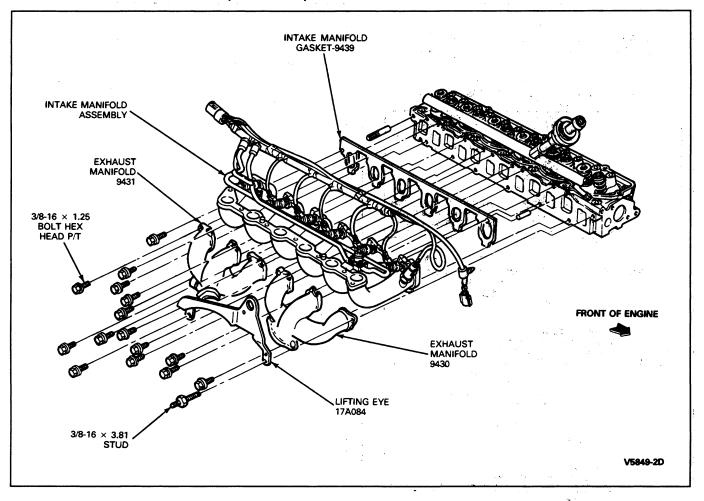


PULL THE COUPLING MALE AND FEMALE FITTINGS APART



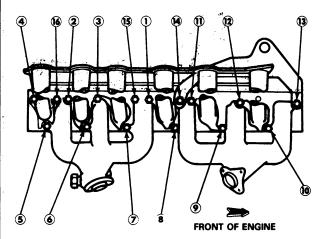
V4803-C

- 16. Remove 16 bolts attaching both the lower intake manifold and the exhaust manifolds to the cylinder head. Do not remove the bolts that attach only the exhaust manifolds.
- 17. Remove the lower intake manifold assembly from the cylinder head.



#### Installation

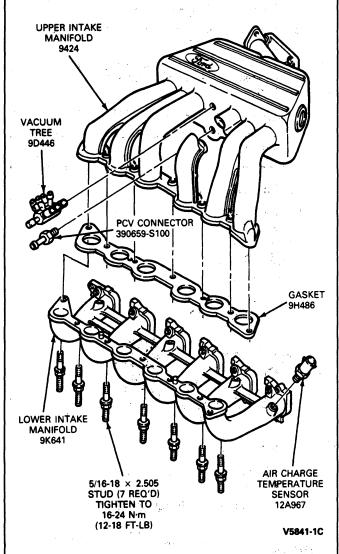
- Clean and inspect the mounting faces of the lower intake manifold and the cylinder head. Both surfaces must be clean and flat.
- 2. Clean and oil manifold bolt threads.
- Position the lower intake manifold and a new gasket to the cylinder head, and install the attachment bolts. Tighten the bolts to 29.8-43.8
   N·m (22-32 ft-lb) in the sequence shown.



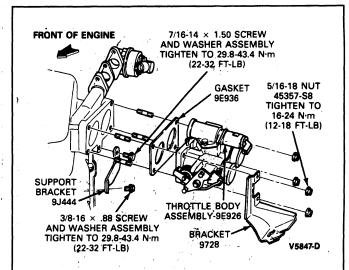
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 Position the vacuum harness, then attach the vacuum connection to the fuel pressure regulator.

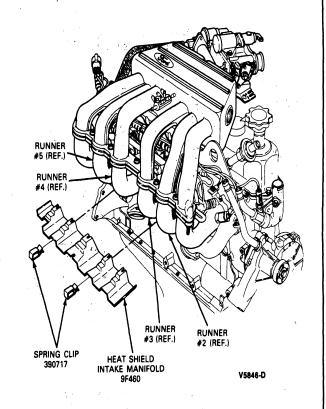
Install a new upper intake gasket on the lower manifold, using the lower manifold dowels to position the gasket.



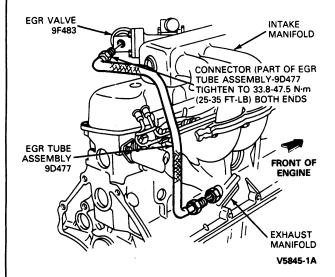
- 6. Position the upper intake manifold onto the lower intake manifold, using the dowels of the lower intake to locate manifold holes. Install the seven studs attaching the upper intake to the lower intake manifold, hand-tighten. Then tighten the studs to 16.2-24.4 N·m (12-18 ft-lb).
- Position the upper intake manifold support onto the boss of the upper intake, located under the throttle body. Install the retaining screw and tighten to 29.8-43.8 N·m (22-32 ft-lb).



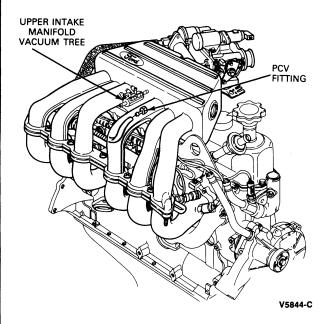
 Install the injector heat shield between the lower intake manifold and the exhaust manifolds.
 Secure the shield to the lower intake manifold by installing the two spring clips between the intake runners.



 Install the EGR tube between the EGR valve and the rear exhaust manifold. The tube is routed between lower intake runners No. 4 and No. 5. Tighten both fittings to 33.8-47.5 N·m (25-35 ft-lb).

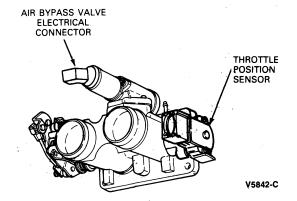


10. Connect the PCV hose to the fitting, located on the underside of the upper intake manifold.

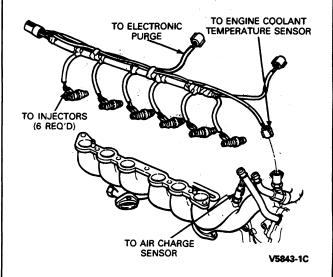


- 11. Position the Thermactor tube assembly onto the studs of the lower intake manifold. Tighten the attachment nuts to 10.8-16.3 N·m (8-12 ft-lb).
- 12. For Econoline applications, position the transmission fill tube onto the stud of the lower intake manifold. Tighten the attachment nut to 10.8-16.3 N·m (8-12 ft-lb).
- Install the accelerator cable and throttle linkage shield onto the accelerator bracket of the throttle body.

- 14. Connect the air inlet hoses to the throttle body.
- 15. Connect the following vacuum connections:
  - a. Vacuum line to the EGR valve.
  - Vacuum lines to the Thermactor air bypass valve.
  - Sealed Housing Evaporative Determination System (S.H.E.D.) evap lines to the throttle body.
  - d. Vacuum line to fuel pressure regulator.
  - e. Vacuum lines to the upper intake manifold vacuum tree.
- 16. Connect the following electrical connectors at:
  - a. Throttle position sensor.
  - b. Air bypass valve.



- c. EVP sensor.
- Injector wiring harness to main engine harness.
- e. Electronic purge (if equipped).



 Connect air intake hose, air bypass hose, and crankcase vent hose.

- 18. Connect battery ground cable.
- Install engine coolant following instructions listed on decal located on EEC vacuum reservoir cover.
- 20. Replace fuel pressure relief cap. Build up fuel pressure as follows: without starting the engine, turn ignition switch back and forth at least six times from ON to OFF position, leaving ignition on for five seconds each time. Check for fuel leaks.
- 21. Start engine and allow to run at idle until engine temperature stabilizes. Check for cooling system leaks.
- 22. Use Rotunda SUPER STAR II 007-00041-A or equivalent, with EEC self-test connector to check proper EEC-IV system operation. Refer to the Engine / Emission Diagnosis\* manual.
- 23. Verify correct engine idle.
- 24. Remove protective covers and close hood.

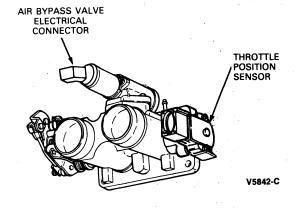
#### **Assembly and Disassembly**

The following is a step-by-step sequence of operations for servicing the assemblies of the fuel charging manifold. Some components may be serviced on the vehicle without a complete disassembly of the fuel charging manifold. Pictorial references demonstrate component removal and installation on and/or off the vehicle.

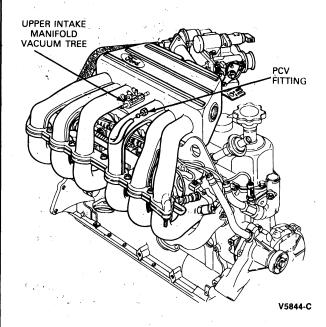
## Upper Intake Manifold and Throttle Body Assembly

#### Removal

- 1. Disconnect the electrical connectors at:
  - a. EVP sensor, located on the EGR valve.
  - b. Throttle position sensor.
  - c. Air bypass valve.



- 2. Disconnect the following vacuum connections:
  - a. Vacuum line at the EGR valve.
  - b. Sealed Housing Evaporative Determination System (S.H.E.D.) evap lines to the throttle body and electronic purge, if equipped.
  - Vacuum lines to the upper intake manifold vacuum tree. Labeling the hose locations with tape is recommended to aid installation.

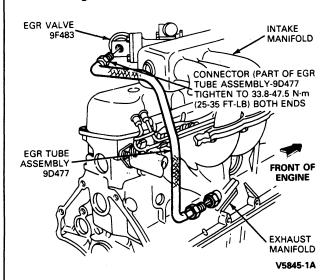


- Disconnect the PCV hose from the fitting, located on the underside of the upper intake manifold.
- Remove the throttle linkage shield, and disconnect the throttle linkage and speed control cables. Unbolt the accelerator cable from the bracket and position the cable away from the engine.

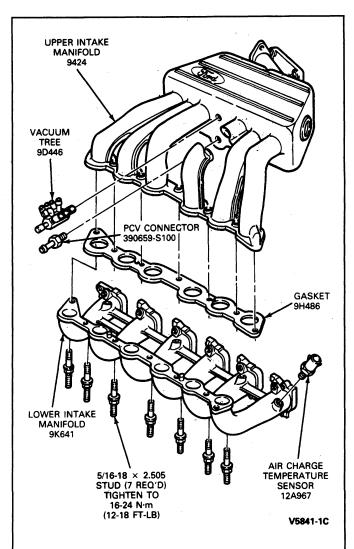
CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the ball stud to pry off. Removing by hand may damage the cable.

Disconnect the air inlet hoses from the throttle body.

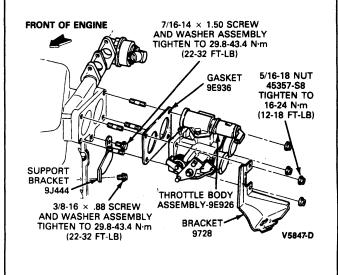
6. Disconnect the EGR tube from the EGR valve and the rear exhaust manifold. Remove the tube from the engine.



- Remove the Thermactor tube assembly from the lower intake manifold by removing the two nuts retaining the tube. Remove the nut attaching the Thermactor bypass valve bracket to the lower intake manifold.
- For E-series applications only, remove the nut attaching the transmission fill tube. Then remove the tube bracket off the intake manifold stud.
- Remove the seven studs that retain the upper intake manifold.

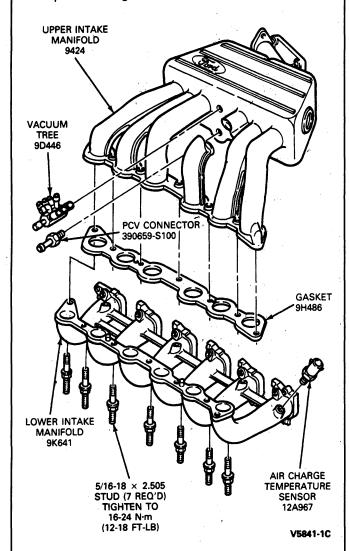


- Remove the screw and washer assembly attaching the upper intake manifold support bracket to the upper intake manifold.
- Remove the upper intake manifold and throttle body assembly from the lower intake manifold.



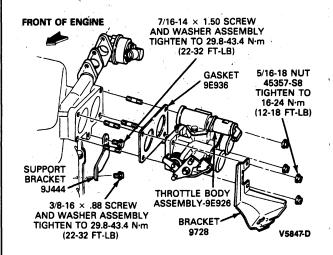
#### Installation

 Position a new upper intake gasket on the lower manifold, using the lower manifold dowels to position the gasket.

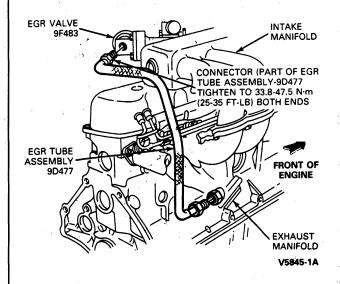


 Position the upper intake manifold onto the lower intake manifold, using the dowels of the lower intake to locate manifold holes. Install the seven studs to attach the upper intake to the lower intake manifold, hand-tighten.

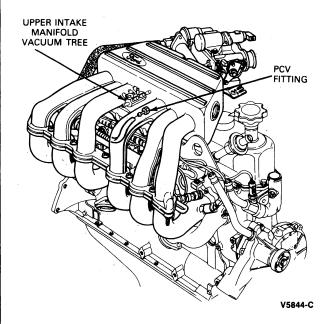
- Tighten the seven studs, attaching the upper intake to the lower intake manifold, to 16.2-24.4 N-m (12-18 ft-lb).
- Position the upper intake manifold support onto the boss of the upper intake, located under the throttle body. Install the retaining screw and tighten to 29.8-43.4 N·m (22-32 ft-lb).



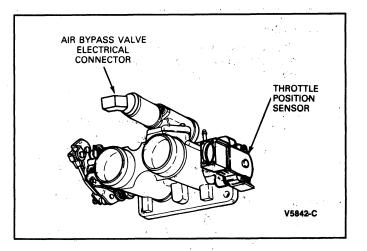
 Install the EGR tube between the EGR valve and the rear exhaust manifold. The tube is routed between lower intake runners No. 4 and No. 5. Tighten both fittings to 33.8-47.5 N⋅m (25-35 ft-lb).



 Connect the PCV hose to the fitting, located on the underside of the upper intake manifold.



- Position the Thermactor tube assembly onto the studs of the lower intake manifold, and tighten the attachment nuts to 10.8-16.3 N·m (8-12 ft-lb).
- 8. For Econoline applications, position the transmission fill tube onto the stud of the lower intake manifold. Tighten the attachment nut to 10.8-16.3 N·m (8-12 ft-lb).
- Install the accelerator cable and throttle linkage shield onto the accelerator bracket of the throttle body.
- 10. Connect the air inlet hoses to the throttle body.
- 11. Connect the following vacuum connections:
  - a. Vacuum line to the EGR valve.
  - Sealed Housing Evaporative Determination System (S.H.E.D.) evap lines to the throttle body.
  - Vacuum lines to the upper intake manifold vacuum tree.
- 12. Connect the following electrical connectors at:
  - a. Throttle position sensor.
  - b. Air bypass valve.
  - c. EVP sensor.
  - d. Electronic purge valve, if equipped.



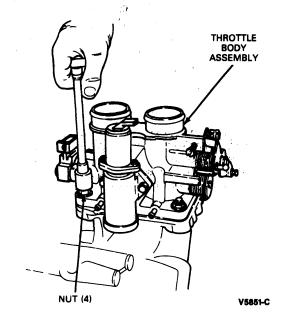
## Air Intake Throttle Body

#### Remova

- Disconnect throttle position sensor and air bypass valve connectors.
- Disconnect throttle linkage shield, throttle cable, and speed control cable.

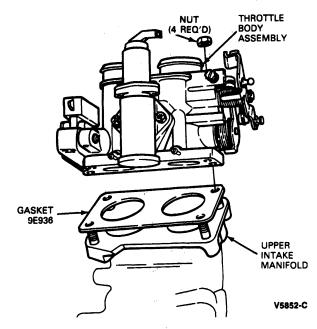
CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the ball stud to pry off. Removing by hand may damage the cable.

- 3. Disconnect the air inlet hoses from the throttle body.
- Disconnect the SHED EVAP harness from the purge ports of the throttle body.
- 5. Remove four throttle body nuts.



 Carefully separate air throttle body and accelerator bracket from upper intake manifold.

 Remove and discard gasket between throttle body and upper intake manifold.

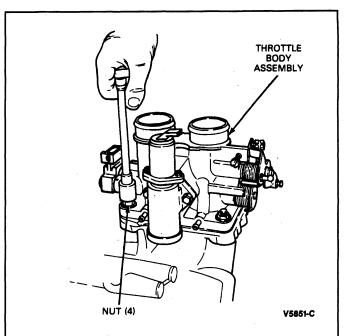


#### Installation

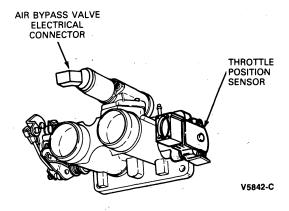
 Ensure that both throttle body and upper intake manifold gasket surfaces are clean.

NOTE: If scraping is necessary, be careful not to damage gasket surfaces of throttle body and upper manifold assemblies, or allow material to drop into manifold.

- Install a new (9E936) throttle body gasket on the four studs of the upper intake manifold.
- Position the accelerator bracket onto the throttle body.
- 4. Install throttle body to upper intake manifold.
- Secure throttle body assembly to upper intake manifold with four retaining nuts. Tighten to 16-24 N·m (12-18 ft-lb).



Connect air bypass valve and throttle position sensor electrical connectors.



- Connect the SHED EVAP harness to the purge ports of the throttle body.
- 8. Connect the throttle linkage and cables to the throttle body and accelerator bracket.
- 9. Connect the air inlet hoses to the throttle body.

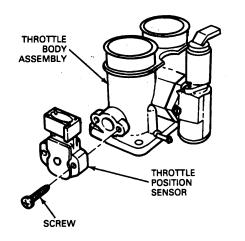
V4802-E

#### REMOVAL AND INSTALLATION (Continued)

#### **Throttle Position Sensor**

#### Removal

Disconnect throttle position sensor from wiring harness.



- 2. Remove two throttle position sensor retaining
- Remove throttle position sensor.

#### Installation

Position the throttle position sensor so that the connector points opposite the air valve. Then, rotate throttle position sensor clockwise to align scribe marks.

**CAUTION: Slide rotary tangs into position** over throttle shaft blade, then rotate throttle position sensor CLOCKWISE ONLY to installed position. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.

Secure sensor to throttle body assembly with two 2. retaining screws. Tighten to 2.0-3.0 N·m (17.7-26.5 in-lb).

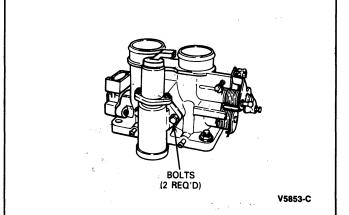
NOTE: When throttle position sensor is installed on the throttle body, the connector will point toward the throttle body inlet.

Connect electrical connector to harness.

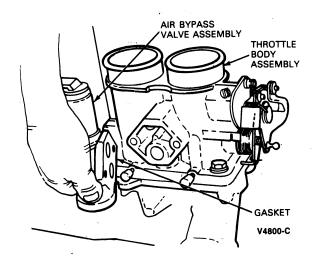
## **Air Bypass Valve Assembly**

#### Removal

- Disconnect the air bypass valve assembly connector from the wiring harness.
- Remove the two air bypass valve retaining bolts.



Remove the air bypass valve and gasket.

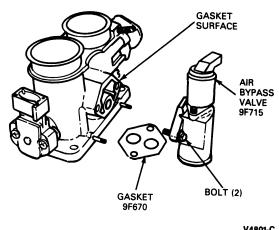


#### Installation

Ensure that both throttle body and air bypass valve gasket surfaces are clean.

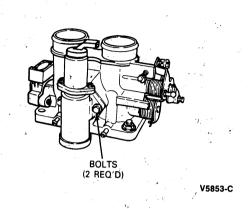
NOTE: If scraping is necessary, be careful not to damage air bypass valve or throttle body gasket surfaces, or drop material into throttle body.

Install gasket and air bypass valve on throttle body surfaces.



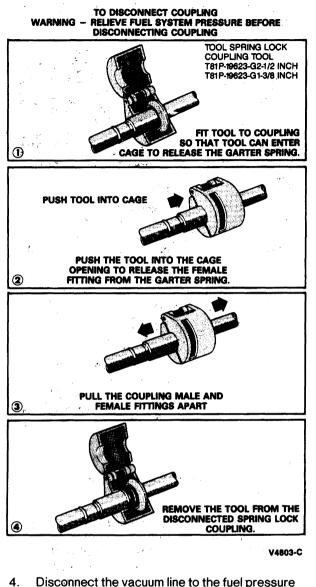
V4801-C

- Install retaining screws. Tighten to 8-11 N-m (71-102 in-lb).
- 4. Connect electrical connector for the air bypass



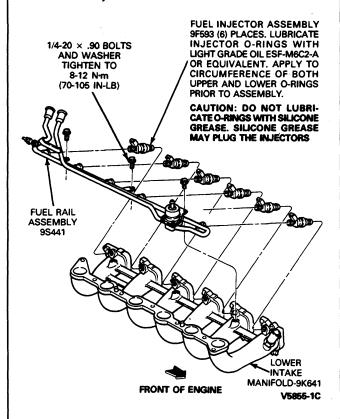
## Fuel Supply Manifold Assembly Removal

- Remove the upper intake manifold assembly as outlined in this Section.
- 2. Disconnect fuel line retaining clips.
- Disconnect the fuel supply and fuel return lines using Spring Lock Coupling Disconnect Tool D87L-9280-A or D87L-9280-B or equivalent.



- Disconnect the vacuum line to the fuel pressure regulator.
- Remove the strap surrounding the fuel manifold, injector electrical harness, and the main vacuum harness.
- Remove the three fuel supply manifold retaining studs.

7. Carefully disengage the fuel supply manifold from the fuel injectors and remove the manifold.

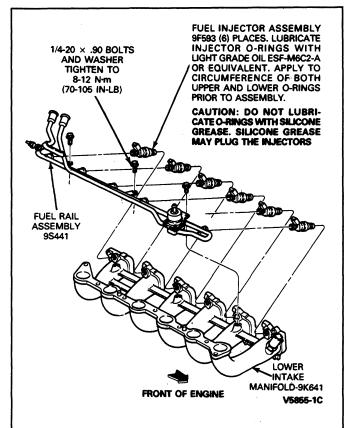


#### Installation

 Ensure injector caps are clean and free of contamination.

CAUTION: Do not attempt to clean the injector pintle or metering orifice area with brush or tools. Use Rotunda Injector Cleaner/Tester 113-00001 or equivalent.

 Place the fuel supply manifold over each of the injectors and seat the injectors into the fuel supply manifold. Ensure injectors are well seated in the fuel supply manifold assembly.



- Secure the fuel supply manifold assembly using the three retaining bolts. Tighten to 7.9-11.9 N·m (70-105 in-lb).
- Attach the vacuum line to the fuel pressure regulator.
- Secure the main vacuum harness and the injector electrical harness to the fuel supply manifold with a strap positioned between the No. 5 and No. 6 intake manifold runners.
- Connect the electrical connector to the electronic purge valve, if equipped.
- 7. Connect the fuel inlet and outlet lines at the fuel rail connections. Refer to the following illustration.
- 8. Connect fuel line retaining clips.

9. Install the upper intake manifold as outlined in this Section. REPLACEMENT GARTER SPRINGS **GARTER** 3/8 INCH - E1ZZ-19E576-A\* 1/2 INCH - E1ZZ-19E576B\* 5/8 INCH - E35Y-19E576-A\* SPRING 3/4 INCH - E69Z-19E576-A ALSO AVAILABLE IN E35Y-19D690-A KIT WITH O-RINGS CHECK FOR MISSING OR DAMAGED GARTER SPRING - REMOVE DAMAGED SPRING WITH SMALL HOOKED WIRE - INSTALL NEW SPRING ◑ IF DAMAGED OR MISSING. **INSTALL NEW** A - CLEAN FITTINGS O-RINGS - USE ONLY SPECIFIED O-RINGS UBRICATE WITH D -ASSEMBLE FITTING **CLEAN ENGINE** TOGETHER BY PUSHING OIL WITH A SLIGHT TWISTING 2 MOTION **GARTER** SPRING TO ENSURE COUPLING ENGAGEMENT, VISUALLY CHECK TO BE SURE GARTER SPRING IS OVER

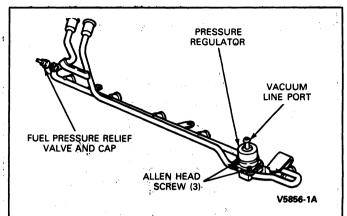
## Fuel Pressure Regulator

FLARED END OF FEMALE FITTING.

#### Removal

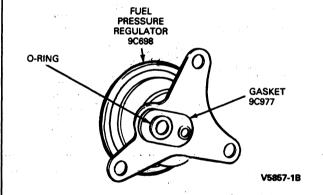
3

 Ensure assembly is depressurized by removing fuel filler cap and releasing pressure from fuel system by opening the pressure relief valve on the fuel line in the upper RH corner of the engine compartment. Use fuel Pressure Gauge T80L-9974-B or equivalent.



- 2. Remove vacuum line at pressure regulator.
- Remove three Allen retaining screws from regulator housing.
- Remove pressure regulator assembly, gasket and O-ring. Discard gasket and inspect O-ring for signs of cracks or deterioration.

NOTE: If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line gasket surfaces.



#### Installation

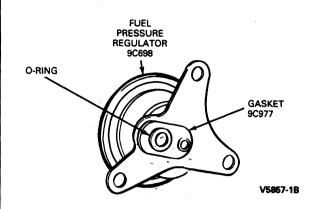
V5908-1B

 Lubricate fuel pressure regulator O-ring with light oil ESF-M6C2-A or equivalent.

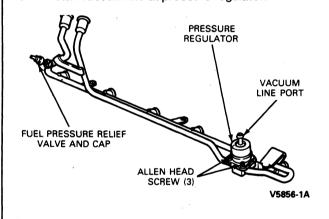
CAUTION: Never use silicone grease. It will clog the injectors.

Make sure gasket surfaces of fuel pressure regulator and fuel injection manifold are clean.

Install O-ring and new gasket on regulator.



- Install fuel pressure regulator on injector manifold. Tighten three retaining screws to 3.0-4.5 N·m (27-40 in-lb).
- 5. Install vacuum line at pressure regulator.



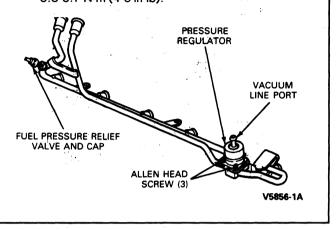
## Pressure Relief Valve

#### Removal

- If the fuel charging assembly is mounted to the engine, remove fuel filler cap and release pressure from the system by opening the pressure relief valve on the fuel line in the upper RH corner of the engine compartment. Use Fuel Pressure Gauge T80L-9974-B or equivalent.
  - NOTE: The cap on the relief valve must be removed.
- Using an open-end wrench, remove pressure relief valve from fuel line.

#### Installation

 Install pressure relief valve and cap. Tighten valve to 5.5-9.5 N·m (48-84 in-lb). Tighten cap to 0.5-0.7 N·m (4-6 in-lb).



#### **Fuel Injection Wiring Harness**

#### Removal

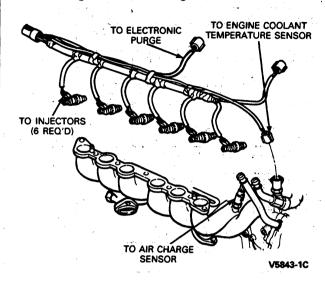
NOTE: Ensure ignition is in OFF position and fuel system is depressurized.

- Disconnect electrical connectors from all six fuel injectors.
- 2. Disconnect connector from main wiring harness.
- Disconnect electrical connectors at electronic purge valve (if equipped), air charge temperature switch, and coolant temperature switch.
- 4. Remove wiring assembly.

#### Installation

- Position wiring harness alongside the fuel injectors.
- Snap electrical connectors into position on all six injectors.
- 3. Connect main harness connector.
- Connect electrical connectors at fuel temperature switch, air charge temperature switch, and coolant temperature switch.
- Verify that all electrical connectors are firmly seated.

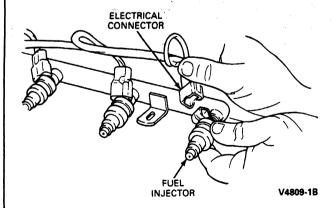
6. Use Rotunda SUPER STAR II 007-00041-A or equivalent, with EEC self-test connector and procedure to check for sensor function. Refer to the Engine / Emission Diagnosis\* manual.



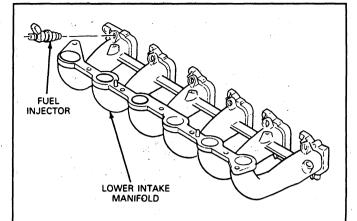
#### **Fuel Injector**

#### Removal

- Perform Steps 1 through 5 under Fuel Charging Assembly—Pre-Service Procedures.
- Remove upper intake manifold as outlined in this Section.
- Carefully remove electrical harness connectors from individual injectors as required.
- Remove fuel supply manifold as outlined in this Section.



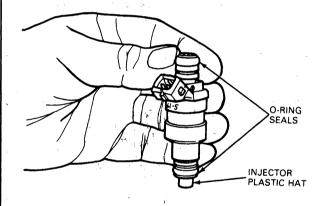
 Grasping injector body, pull up while gently rocking injector from side-to-side.



V5858-1A

Inspect injector O-rings (two per injector) for signs of deterioration. Replace as required.

CAUTION: Do not attempt to clean the injector pintle or metering orifice with tools or brushes. Use Rotunda Injector Cleaner/Tester 113-00001 or equivalent.



V5040-1A

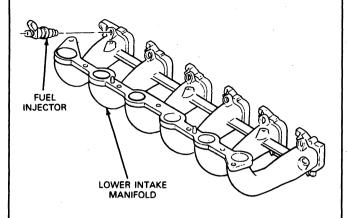
#### Installation

 Lubricate new O-rings with light grade oil ESF-M6C2-A or equivalent and install two on each injector.

CAUTION: Never use silicone grease. It will clog the injectors.

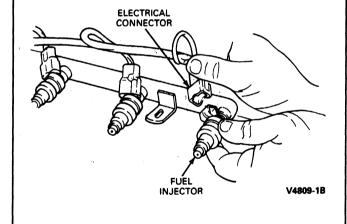
Install injector(s) using a light, twisting, pushing motion.

 Install fuel supply manifold as outlined in this Section.



V5858-1A

- 4. Install electrical harness connectors to injectors.
- Install upper intake manifold as outlined in this Section. Perform Steps 1 through 5 of Fuel Charging Assembly—Pre-Service Procedures.



#### **SPECIFICATIONS**

| Description   | N·m       | Ft-Lb              |
|---|-----------|--------------------|
| Lower Intake Manifold to Head                           | 30-43     | 22-32              |
| EGR Tube  | 33.8-47.5 | 25-35              |
| EGR Valve to Upper Intake Manifold                      | 17-25     | 13-19              |
| Cooling Manifold  | 4-5.6     | 35-50<br>(In-Lb)   |
| Upper Intake Manifold to Lower Intake<br>Manifold Bolts | 16-24     | 12-18              |
| Throttle Body to Upper Intaké Manifold                  | 16-24     | 12-18              |
| Air Bypass Valve to Throttle Body                       | 8-11      | 71-102<br>(In-Lb)  |
| Throttle Position Sensor to Throttle<br>Body            | 2.0-3.0   | 18-26.5<br>(În-Lb) |
| Fuel Pressure Regulator to Injector<br>Manifold         | 3-4:5     | 27-40<br>(ln-Lb)   |
| Fuel Injector Manifold to Fuel Charging Assembly        | 16-20     | 12-15              |
| Coil Bracket to Manifold Stud                           | 5.9-7.4   | 52-65<br>(In-Lb)   |
| Throttle Cable Bracket to Manifold                      | 11-13     | 8-10               |
| Air Door Bracket to A/C Cleaner                         | 7.9-11.2  | 70-100<br>(ln-Lb)  |

#### **SPECIAL SERVICE TOOLS**

|             | T   |
|-------------|---|
| Tool Number | Description                                   |
| D87L-9280-B | Spring Lock Coupling Disconnect Tool 1/2 inch |
| D87L-9280-A | Spring Lock Coupling Disconnect Tool 3/8 inch |
| T80L-9974-B | EFI Fuel Pressure Test Gauge                  |

#### **ROTUNDA EQUIPMENT**

| Tool Number | Description             |
|-------------|-------------------------|
| 007-00041-A | SUPER STAR II           |
| 113-00001   | Injector Cleaner/Tester |

## SECTION 03-04C Fuel Charging and Controls—7.5L

| · · · · · · · · · · · · · · · · · · · |          |   |           |
|---------------------------------------|----------|---|-----------|
| SUBJECT                               | PAGE     | SUBJECT                                 | PAGE      |
| CLEANING AND INSPECTION               |          | REMOVAL AND INSTALLATION                |           |
| Air Bypass Valve                      | 03-04C-5 | Air Intake Throttle Body                | 03-04C-7  |
| COMPONENTS                            |          | Fuel Charging Assembly                  | 03-04C-6  |
| Fuel Injectors                        | 03-04C-3 | Fuel Injector                           | 03-04C-11 |
| Fuel Pressure Regulator               | 03-04C-4 | Fuel Pressure Regulator                 | 03-04C-11 |
| Fuel Supply Manifold Assembly         | 03-04C-5 | Fuel Supply Manifold Assembly           | 03-04C-9  |
| Throttle Air Bypass Valve Assembly    | 03-04C-4 | Throttle Air Bypass Valve Assembly      |           |
| Throttle Body Assembly                | 03-04C-4 | Throttle Position Sensor                | 03-04C-8  |
| DESCRIPTION                           |          | Upper Intake Manifold and Throttle Body | 03-04C-6  |
| OPERATION                             |          | SPECIAL SERVICE TOOLS                   | 03-04C-13 |
| Air Intake Manifold                   | 03-04C-3 | SPECIFICATIONS                          | 03-04C-13 |
|                                       |          | VEHICLE APPLICATION                     | 03-04C-1  |
|                                       |          |   |           |

#### VEHICLE APPLICATION

Vehicles Equipped with 7.5L EFI V-8 Engines.

#### **DESCRIPTION**

The Electronic Fuel Injection system (EFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Injectors pulse to follow engine firing order in accordance with engine demand through injectors mounted on a tuned intake manifold.

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

An on-board vehicle electronic engine control (EEC-IV) computer accepts input from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air/fuel ratio throughout the entire engine operational range. The computer then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

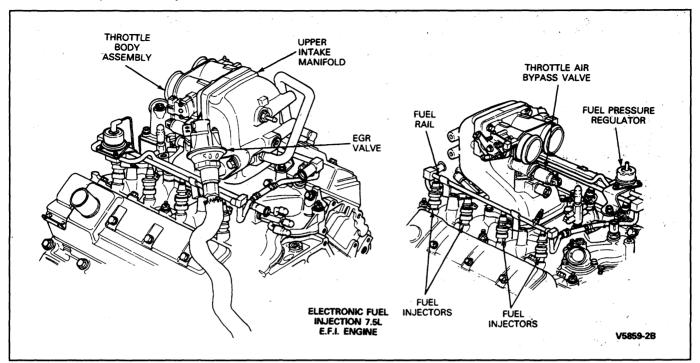
The EEC-IV engine control system also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains) and will also permit push-starting the vehicle should it become necessary (manual transmission only).

#### **OPERATION**

The fuel delivery subsystem consists of a high pressure in-tank mounted fuel pump and a fuel filter/reservoir delivering fuel from the fuel tank through a 20 micron fuel filter to a fuel charging manifold assembly.

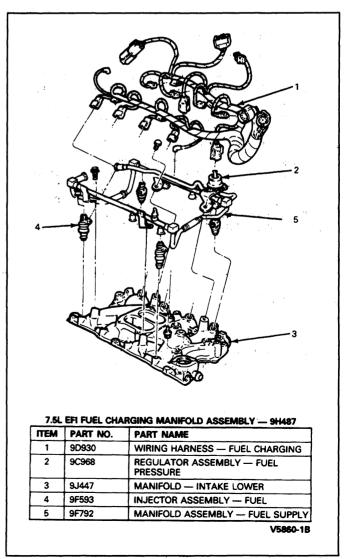
The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

#### **OPERATION (Continued)**



A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank through a fuel return line.

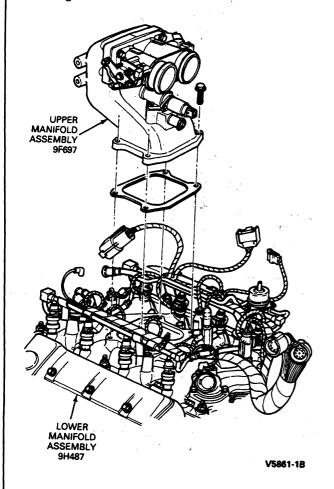
One group of four injectors is energized simultaneously, once every crankshaft revolution, followed by the second group of injectors in the next crankshaft revolution. The period of time that the injectors are energized (injector "on time" or pulse width) is controlled by the vehicle's Electronic Engine Control (EEC-IV) computer. The EEC computer receives input from various engine sensors and uses this information to compute the required fuel flow rate necessary to compute the prescribed air / fuel ratio for the given engine operation. The computer determines the needed injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.



#### **OPERATION (Continued)**

#### Air Intake Manifold

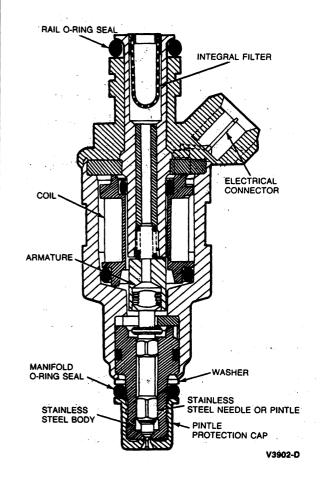
The air intake manifold is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body assembly, fuel supply manifold and accelerator control bracketry and the EGR valve and supply tube. Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets in which the injectors are mounted are placed to direct the injector fuel spray immediately in front of each engine intake valve.



#### **COMPONENTS**

#### **Fuel Injectors**

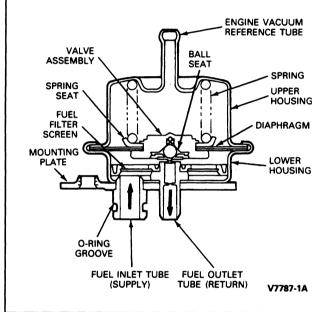
The fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The EFI injectors are mounted in the lower intake manifold and are positioned so that their tips directing fuel just before of the engine intake valves. The valve body consists of a solenoid actuated valve assembly, therefore, fuel flow to the engine is regulated only by how long the solenoid is energized. An electrical signal from the EEC unit activates the solenoid, causing the pintle to move inward, off the seat, allowing the fuel to flow through the orifice. Atomization of the fuel is obtained by contouring the pintle at the point where the fuel separates.



#### **COMPONENTS (Continued)**

#### **Fuel Pressure Regulator**

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel in excess of that used by the engine is bypassed through the regulator and returns to the fuel tank.

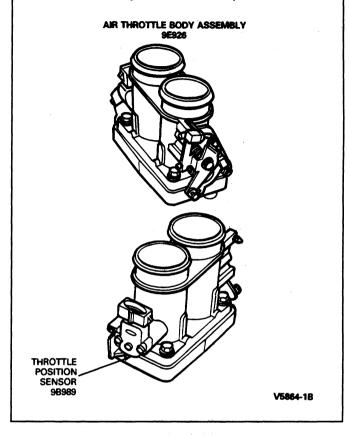


#### Throttle Body Assembly

The throttle body assembly controls airflow to the engine through a butterfly-type valve. The throttle angle is controlled by a multiple-link, progressive opening throttle linkage. The body is a single piece die casting made of aluminum.

Other features of the air throttle body assembly include:

- 1. A pre-set stop to locate the WOT position.
- 2. A throttle body-mounted throttle position sensor.

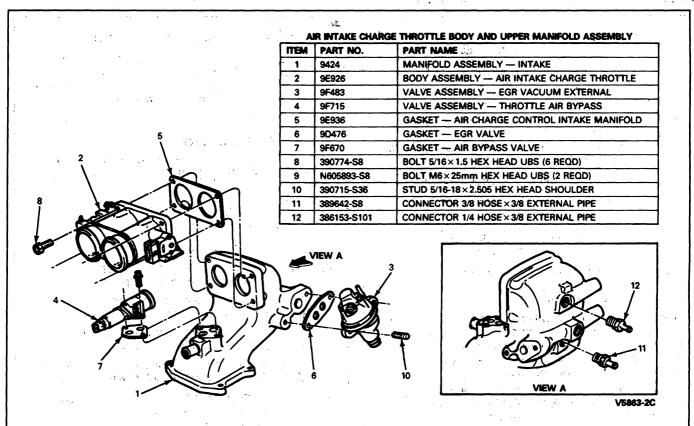


#### **Throttle Air Bypass Valve Assembly**

The upper intake manifold has a mounting pad on which the throttle air bypass valve assembly is located. The intake manifold has an air bypass channel downstream of the throttle body with external filtered air supplied from the air cleaner.

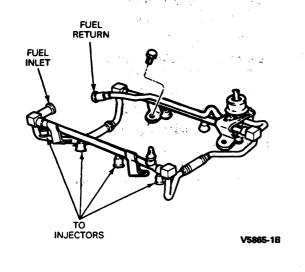
The valve assembly is an electro-mechanical device controlled by the EEC-IV computer. It uses a linear actuator which positions a variable area metering valve. This controls the engine airflow for both cold and warm engine idle.

#### **COMPONENTS** (Continued)



#### **Fuel Supply Manifold Assembly**

The fuel supply manifold assembly delivers high-pressure fuel from the vehicle fuel supply line to the eight fuel injectors. The assembly consists of two banks of tubular fuel rails connected by two permanent crossover connections, eight injector connectors, a mounting flange to the fuel pressure regulator and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention. The fuel inlet and outlet connections have push-connect fittings. The unit is serviced as an assembly only.



#### **CLEANING AND INSPECTION**

#### Air Bypass Valve

CAUTION: Do not use the cleaning procedure on Nipondenso bypass valves, as valve damage may occur.

#### **Recommended Cleaning Procedure**

CAUTION: Do not clean black plastic bypass valves. Use only specified cleaner. Do not spray directly on throttle plate or use any type of scrubbing method. Do not run engines of vehicles with airflow meters during cleaning.

- Ensure bypass actuator is operating properly. Refer to Engine / Emissions Diagnosis\* manual.
- 2. Remove throttle inlet air tube.
- 3. Disconnect air bypass valve connector.
- Connect Rotunda Air Bypass Actuator 113-00009 and Injector Tester / Cleaner 113-00001 or equivalent.
- Start the actuator and then start the engine on vehicles that **do not** have airflow meters. **Do not** start engines of vehicles equipped with airflow meters.
- Spray Carburetor Cleaner D9AZ-19579-BA or equivalent into air bypass valve for five seconds while actuator is operating.

<sup>\*</sup>Can be purchased as a separate item.

#### **CLEANING AND INSPECTION (Continued)**

- 7. Turn off the actuator and stop engine. Allow solvent to soak for 15 minutes.
- Turn on actuator and start engine. Do not start engines on vehicles equipped with an airflow meter.
- On vehicles with airflow meters, spray carburetor cleaner into idle air bypass passage for no more than six seconds. On other vehicles, spray for up to one minute.
- 10. Turn off actuator and stop engine, if running.
- Install intake air tube. Start actuator and engine and run engine for one minute.
- 12. Disconnect actuator from bypass valve. Connect bypass valve electrical connector.
- 13. Start engine and check for proper operation.

#### **Alternate Cleaning Procedure**

Remove the air bypass valve from the throttle body assembly. Remove the electrical solenoid assembly from the mechanical portion of the air bypass valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A), or equivalent for 2 to 3 minutes maximum.

CAUTION: Do not exceed 3 minutes soak time, and do not use choke cleaner as an internal O-ring may begin to deteriorate.

With the mechanical portion completely submerged, shake in all directions: up, down, right, and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far a possible.

Remove the unit from the cleaning fluid and dry out thoroughly using shop air.

#### REMOVAL AND INSTALLATION

## Fuel Charging Assembly Throttle Body, Upper and Lower Manifolds Pre-Service Procedures

The fuel charging assembly consists of the air throttle body and the upper and lower intake manifolds. Prior to service or removal of the fuel charging assembly, the following steps must by taken:

- Open hood and install protective covers.
- Disconnect battery ground cable and secure it out of the way.

- 3. Remove fuel cap and release tank pressure.
- Release pressure from fuel system. Refer to Section 24-50 for fuel system pressure relief procedures. A pressure relief (Schrader) valve on the fuel rail assembly is provided for this procedure.

#### **Post-Service Procedures**

After the service is complete and the fuel charging assembly is installed onto engine, the following steps must be taken:

- 1. Install fuel cap at tank.
- 2. Connect battery ground cable.
- Add engine coolant if required.
- Turn ignition switch ON/OFF several times without starting the engine to check for fuel leaks.

NOTE: Check all connections at fuel rails, push-connect fittings, etc.

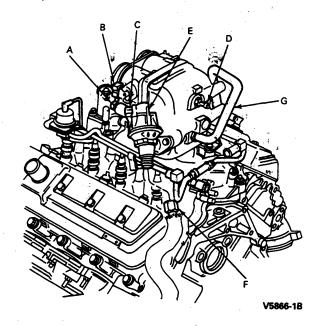
## CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

- Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
- Perform EEC-IV Self Test to check systems function. Refer to the Engine / Emissions Diagnosis\* manual.

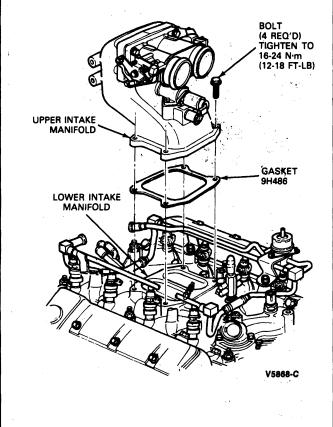
## Upper Intake Manifold and Throttle Body Removal

- Disconnect throttle linkage at throttle ball and automatic transmission linkage, if equipped, from throttle body. Remove two bolts securing bracket to intake and position bracket with cables out of the way.
- 2. Disconnect electrical connectors at:
  - a. throttle air bypass valve
  - b. throttle position sensor
  - c. EGR position sensor
- 3. Disconnect upper intake manifold vacuum fitting connections by disconnecting:
  - a. vacuum line to MAP sensor
  - vacuum line to EGR valve
- Disconnect EGR and PCV systems by disconnecting:
  - a. EGR valve flange nut
  - b. PCV hose at rear of upper manifold

 Disconnect idle bypass valve clean air supply hose, connected to idle speed control bypass port.



- 6. Remove four upper intake manifold retaining bolts.
- 7. Remove upper intake manifold and throttle body as an assembly.



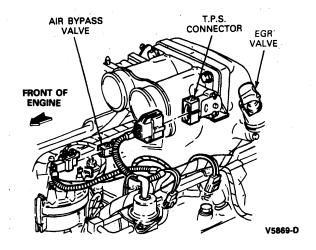
#### Installation

- Clean and inspect the mounting faces of the lower and upper intake manifolds.
- Position new gasket on lower intake mounting face. The use of alignment studs may be helpful.
- Install upper intake manifold and throttle body assembly to lower manifold, ensuring gasket remains in place (if alignment studs are not used).
- Install four upper intake manifold retaining bolts. Tighten to specification.
- 5. Install EGR tube.
- 6. Connect PCV hose to rear of upper manifold.
- Connect vacuum lines to MAP sensor and EGR valve.
- Position throttle linkage bracket with cables to upper intake manifold. Install two retaining bolts and tighten to specification. Connect throttle cable and automatic transmission kickdown cable to throttle body.
- Connect electrical connectors at air bypass valve, TP sensor and EGR position sensor.
- Connect idle bypass valve clean air supply hose.
   NOTE: If lower intake manifold was removed, fill and bleed cooling system as outlined. Refer to Section 27-02, Cooling System General Service.

## Air Intake Throttle Body

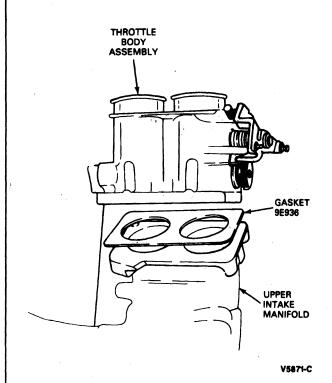
#### Removal

- Disconnect throttle linkage at throttle ball and automatic transmission linkage, if equipped, from throttle body. Remove two bolts securing bracket to intake and position bracket with cable(s) out of the way.
- Disconnect electrical connector at throttle position sensor.



. Remove four throttle body bolts.

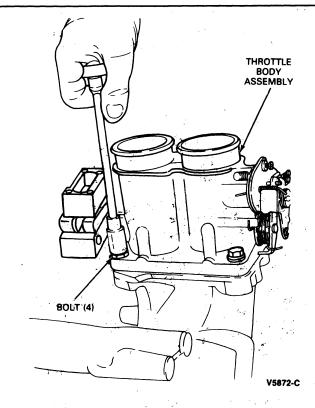
 Carefully separate air throttle body from upper intake manifold.



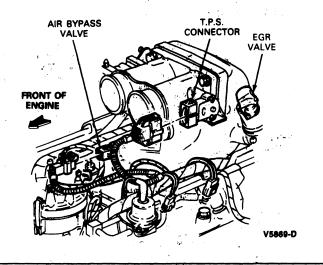
#### Installation

Refer to Section 24-01, Fuel System General Service, for throttle body cleaning and inspection procedures.

- Ensure that both throttle body and upper intake manifold gasket surfaces are clean.
  - NOTE: If scraping is necessary, be careful not to damage gasket surfaces of throttle body and upper manifold assemblies, or allow material to drop into manifold.
- Install throttle body gasket between upper intake manifold and throttle body. Make sure gasket stays in place if alignment studs are not used.
- 3. Install throttle body to upper intake manifold.
- Secure throttle body assembly to upper intake manifold with four retaining bolts. Tighten to 15-24 N·m (12-18 ft-lb).



Connect throttle position sensor electrical connectors.



## Throttle Position Sensor

#### Removal

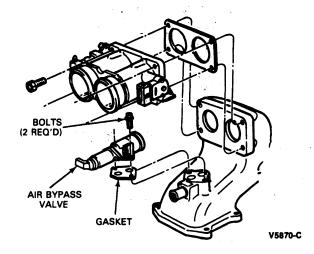
- Disconnect throttle position sensor from wiring harness.
- Scribe a reference mark across the edge of the sensor and to the throttle body to ensure correct position during installation.
- Remove two throttle position sensor retaining screws.
- 4. Remove throttle position sensor.

#### Installation

- Position throttle position sensor so that wiring connector is parallel to the venturi boxes. Then, rotate throttle position sensor clockwise to align scribe marks.
- Secure sensor to throttle body assembly with two retaining screws. Tighten to 1.2-1.8 N·m (11-16 lb-in).
  - NOTE: When throttle position sensor is installed on the throttle body, the wiring connector should be pointing forward on the engine.
- Connect electrical connector to harness.
- Adjust throttle position sensor as outlined in Section 3 of the Engine / Emissions Diagnosis\* manual.

## Throttle Air Bypass Valve Assembly Removal

- Disconnect throttle air bypass valve assembly connector from wiring harness.
- 2. Remove two throttle bypass valve retaining bolts.
- 3. Remove throttle air bypass valve and gasket.



#### Installation

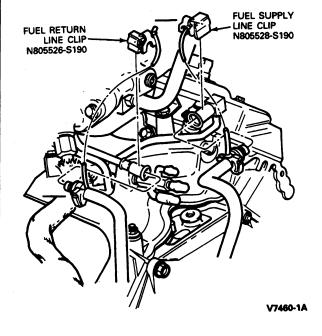
Refer to Section 24-01, Fuel System General Service-Gasoline Engines, for Air Bypass Valve Inspection and Cleaning procedures.

 Ensure that upper intake manifold and throttle air bypass valve gasket surfaces are clean.

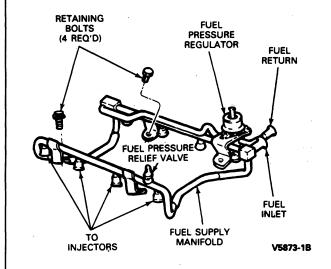
- NOTE: If scraping is necessary, be careful not to damage throttle air bypass valve or intake manifold gasket surfaces, or drop material into intake manifold.
- Install gasket and throttle air bypass valve on upper intake manifold surfaces.
- 3. Install retaining screws. Tighten to 8-11 N-m (71-102 lb-in).
- Connect electrical connector for the throttle air bypass valve.

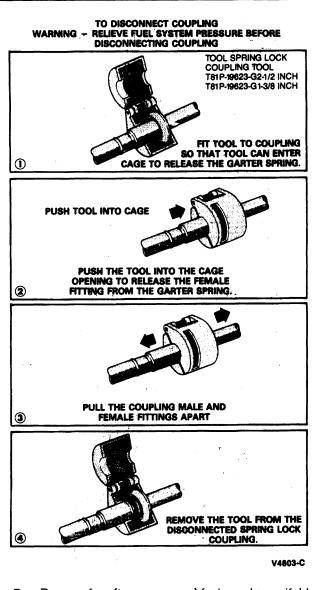
## Fuel Supply Manifold Assembly Removal

- Perform Steps 1 though 4 under Fuel Charging Assembly.
- 2. Remove upper manifold assembly as outlined.
- Relieve the fuel pressure. Refer to Section 24-50, Fuel Tank and Lines and Fuel Evaporative Emission Control System.
- 4. Remove fuel line to fuel rail retainer clips.
- 5. Disconnect vacuum hose to fuel pressure regulator at fuel pressure regulator.



 Using Spring Lock Coupling Disconnect Tool D87L-9280-A or B or equivalent disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.



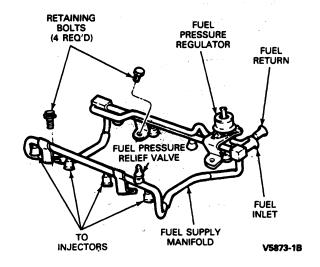


- Remove four (two per group) fuel supply manifold retaining bolts.
- 8. Carefully disengage manifold from fuel injectors and remove manifold.

#### Installation

 Ensure injector caps are clean and free of contamination.

 Place the fuel injector fuel supply manifold over each of the injectors and seat injectors into fuel supply manifold. Ensure injectors are well seated in the fuel manifold assembly.



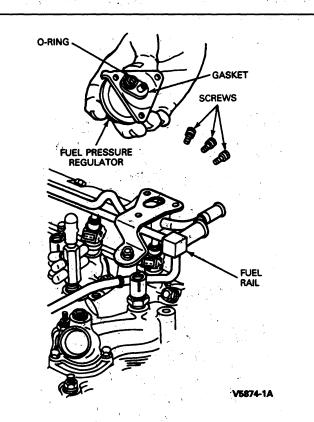
- 3. Secure fuel manifold assembly using four retaining bolts. Tighten to 20-30 N·m (15-22 ft-lb).
- 4. Connect fuel inlet and outlet lines at fuel rail connections. Push in to connect.
- 5. Install fuel line to fuel rail clips.
- 6. Connect vacuum hose to fuel pressure regulator.
- Install upper intake manifold as outlined in this Section.

## **Fuel Pressure Regulator**

#### Removal

- Perform Steps 1 through 4 under Fuel Charging Assembly Pre-Service Procedures if removing fuel pressure regulator while fuel supply manifold is installed on engine.
- 2. Remove vacuum line at pressure regulator.
- Remove three socket head retaining screws from regulator housing.
- Remove pressure regulator assembly, gasket and O-ring. Discard gasket and O-ring.

NOTE: If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line gasket surfaces.



#### Installation

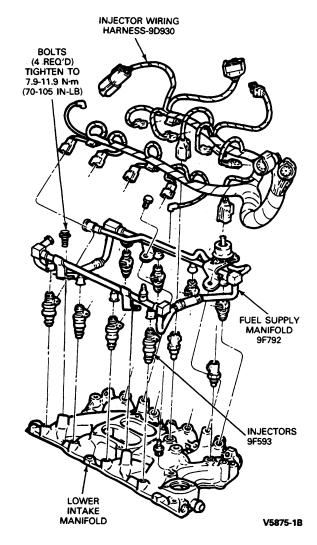
- Lubricate fuel pressure regulator O-ring with light oil ESE-M2C39-F or equivalent.
  - NOTE: Never use silicone grease. It will clog the injectors.
- Ensure gasket surfaces of fuel pressure regulator and fuel injection manifold are clean.
- 3. Install a new O-ring and new gasket on regulator.
- Install fuel pressure regulator on injector manifold. Tighten three retaining screws to 3.0-4.5 N·m (27-40 in-lb).
- 5. Install vacuum line to regulator.
- Perform Steps 1 through 6 under Fuel Charging Assembly Post-Service Procedures.

#### **Fuel Injector**

## Removal

- Perform Steps 1 through 4 under Fuel Charging Assembly Pre-Service Procedures.
- 2. Remove fuel supply manifold as outlined.
- Carefully remove electrical harness connectors from individual injectors as required.

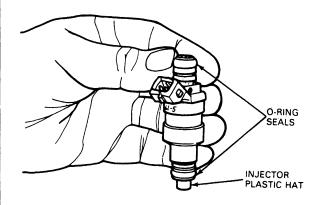
4. Grasping injector body, pull up while gently rocking injector from side-to-side.



5. Inspect injector O-rings (two per injector) for signs of deterioration. Replace as required.

 Inspect injector plastic "hat" (covering the injector pintle) and washer for signs of deterioration. Replace complete injector as required. If "hat" is missing look for it in the intake manifold.

NOTE: Plastic "hat" is not available as a separate part.



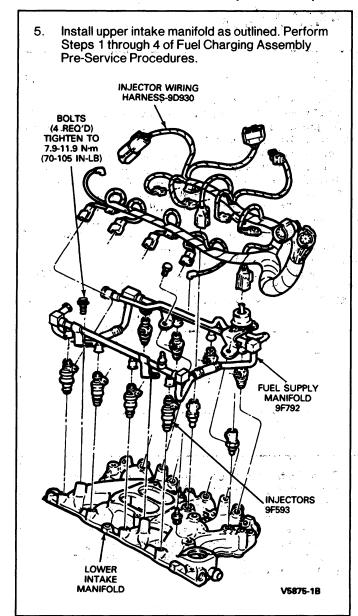
V5040-1A

#### Installation

 Lubricate new O-rings with light grade oil ESE-M2C39-F or equivalent and install two on each injector.

NOTE: Never use silicone grease. It will clog the injectors.

- Install injector(s). Use a light, twisting, pushing motion to install them.
- Install fuel supply manifold as outlined in this Section.
- 4. Install electrical harness connectors to injectors.



## **SPECIFICATIONS**

| Description   | N·m      | Ft-Lb             |
|---|----------|-------------------|
| EGR Tube  | 34-47    | 23-35             |
| EGR Valve to Upper Intake Manifold                      | 8-11     | 70-100<br>(In-Lb) |
| Air Supply Tube Clamps                                  | 1.3-2.25 | 12-20<br>(In-Lb)  |
| Upper Intake Manifold to Lower Intake<br>Manifold Bolts | 16-24    | 12-18             |
| Throttle Body to Upper Intake Manifold                  | 8-11     | 70-100<br>(In-Lb) |
| Air Bypass Valve to Lower Manifold                      | 8-11     | 70-100<br>(In-Lb) |
| Throttle Position Sensor to Throttle<br>Body            | 2.0-3.0  | 18-27<br>(In-Lb)  |
| Fuel Pressure Regulator to Injector<br>Manifold         | 3-4.5    | 27-40<br>(In-Lb)  |
| Fuel Injector Manifold to Fuel Charging Assembly        | 8-12     | 70-105<br>(In-Lb) |
| Coil Bracket to Platform                                | 6-9.5    | 55-88<br>(In-Lb)  |
| Throttle Cable Bracket to Manifold                      | 11-13    | 8-10              |

## **SPECIAL SERVICE TOOLS**

| Tool Number | Description                                     |
|-------------|---|
| D87L-9280-B | Spring Lock Coupling Disconnect Tool (1/2 inch) |
| D87L-9280-A | Spring Lock Coupling Disconnect Tool (3/8 inch) |

## **SECTION 03-05 Engine Accessory Drive**

| SUBJECT PAGE   | SUBJECT PAGE   |
|--|--|
| ADJUSTMENTS  Belt Tension — Alternator and Vacuum Pump                     | DIAGNOSIS AND TESTING (Cont'd.)  Belt Tension — Manually Tensioned Belts03-05- |
| Belt on 7.3L Diesel Engine — Ambulance<br>Models03-05-11                   | Diagnosis Guide03-05-9 REMOVAL AND INSTALLATION                                |
| Belt Tension — Automatically Tensioned Belts03-05-12                       | Accessory Drive Belts  |
| Belt Tension — Manually Tensioned  Belts — F-Series and E-Series with 7.3L | Automatically Tensioned Belts  |
| Diesel Engine and 7.5L Gasoline Engine03-05-9                              | Fan and Viscous Clutch—5.0L, 5.8L and 7.5L                                     |
| Power Steering Pulley Alignment03-05-12 DESCRIPTION                        | Engines03-05-19 Fan and Viscous Clutch—7.3L Diesei                             |
| Accessory Drive Belts  | Manually Tensioned Belts   |
| DIAGNOSIS AND TESTING  Belt Tension — Automatically Tensioned              | SPECIAL SERVICE TOOLS  |
| Belts03-05-7   | VEHICLE APPLICATION  |

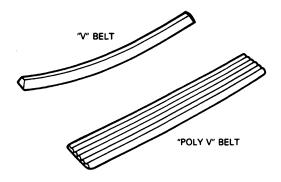
## **VEHICLE APPLICATION**

All Light Truck Vehicles

## **DESCRIPTION**

#### **Accessory Drive Belts**

Ford vehicles are equipped with either "V" drive belts or "poly-V" drive belts. The belt type is selected for each engine based on performance requirements. To ensure maximum belt life, replacement belts should be of the same type and specification as originally installed.



Loose belt(s) will result in slippage which may cause a noise complaint or improper accessory operation (alternator will not charge, etc.). Overly tight belts will place severe loads on accessory bearings and result in premature belt or accessory failure. Refer to the illustrations in this section for the belt routing of each particular engine.

These belts must be properly tensioned at all times.

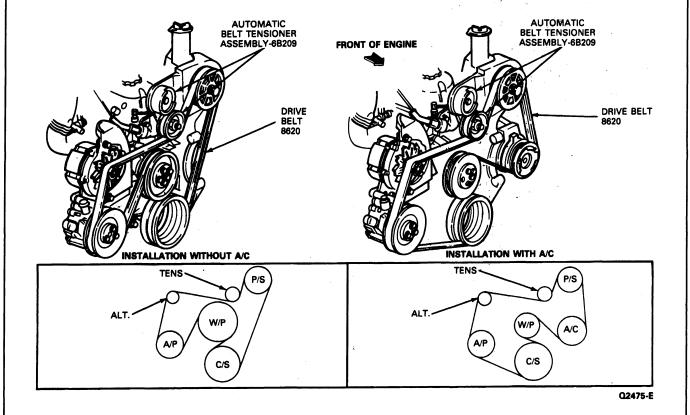
Q1690-1C

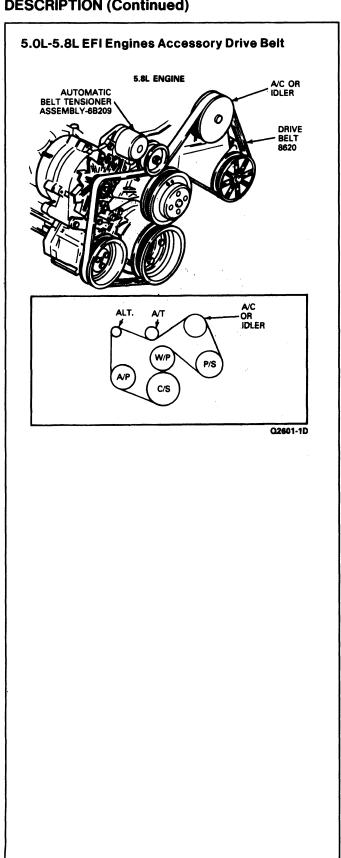
## Fan and Clutch—Engine Operated

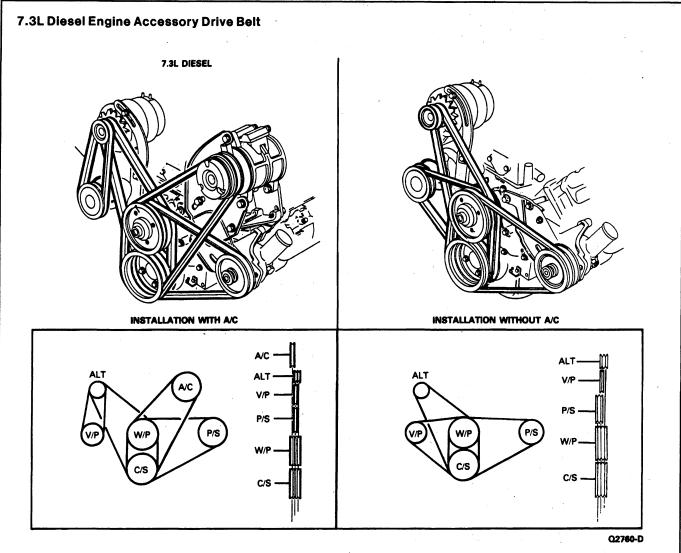
The fan and viscous clutch assembly is used to cool the engine. The fan is driven by the engine through the use of a drive belt(s).

## 4.9L EFI Engine Accessory Drive Belt

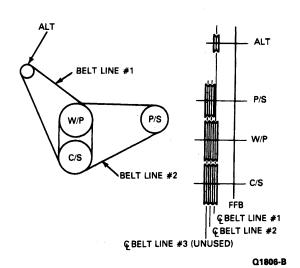
If the fan drive belt(s) is noisy, refer to the Accessory Drive Diagnosis Guide in this section.



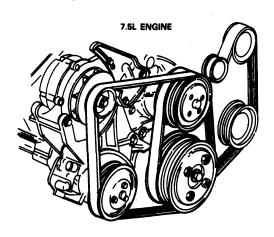


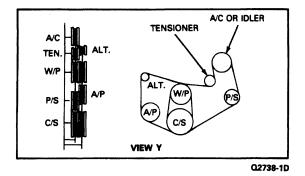


# 7.3L Diesel Engine Accessory Drive Belt—F-Super Duty Commercial Stripped Chassis



## 7.5L EFI Engine Accessory Drive Belt





## **DIAGNOSIS AND TESTING**

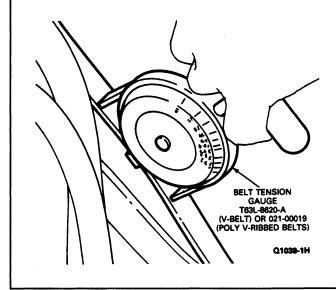
### **Diagnosis Guide**

Find complaint in the following Diagnosis Guide and perform the recommended actions.

|    | CONDITION   | POSSIBLE SOURCE   | ACTION   |
|----|---|---|--|
| Ex | cessive Noise<br>Belt Squeal  | Seized Accessory  Loose Belt  | Check all accessories for free rotation and replace accessory if necessary. Replace belt. Check condition and tension of all belts. Replace belts or adjust tension of manually tensioned belts as necessary. Check that automatic tensioner is within the indicator marks. Check for correct belt length if tensioner is out of operating range |
| •  | Rattle  | Loose Pulley or Accessory   | Check for looseness and tighten.   |
| •  | Noisy Tensioner Pulley Bearing  | Worn Bearing  | Replace pulley per "Automatic Belt<br>Tensioner Pulley" replacement<br>procedure.  |
| •  | Belt Chirp  | Misaligned PS Pulley  | Align PS Pulley per "PS Pulley Alignment Procedure.  |
|    | Severe Belt Flutter   | Loose Belt  Binding Tensioner Arm   | Check belt tension and adjust (manually fensioned belts only) if necessary. Check condition of belt and replace if necessary. Remove belt from automatic tensioner and verify that tensioner arm is not frozen in position or that arm does not bind when manually moved throughout its operating range.   |
|    | Frayed Belt   | Belt not Seated Correctly (poly "V" belt) Severely Misaligned Pulley  Belt Too Tight Belt Worn Out                | Replace belt and verify correct belt seating. Use a straight edge to check for severe angular misalignment between adjacent pulleys. Correct a necessary. Replace belt. Replace belt.  |
|    | Severely Glazed Belt  | Seized Accessory  Loose Belt  | Check all accessories for free rotation and replace if necessary. Replace belt. Replace belt.  |
|    | Improper Accessory Operation<br>(PS or AC doesn't work, engine<br>overheats or battery doesn't<br>charge) | Loose Belt  | Check belt for looseness or glazing and replace or adjust tension of manually tensioned belts if necessary.  |
|    | Belt Jumps off Pulley   | Greatly Misaligned Pulleys  Belt Not Seated Correctly (poly "V" belt) Pulley Wobble  Excessive Crankshaft Endplay | Check for misalignment between adjacent pulleys. Replace belt and verify correct seating. Verify that no pulley wobbles during engine operation. Conditions causin wobble are: bent pulley, bent accessory shaft, rear face of pulley not seated flat against mating surface. Engine rebuild.  |
|    | Excessive Wear on Tensioner<br>Pulley   | Extended Off-Road Operation   | Replace pulley per "Automatic Belt<br>Tensioner Pulley" replacement<br>procedure.  |

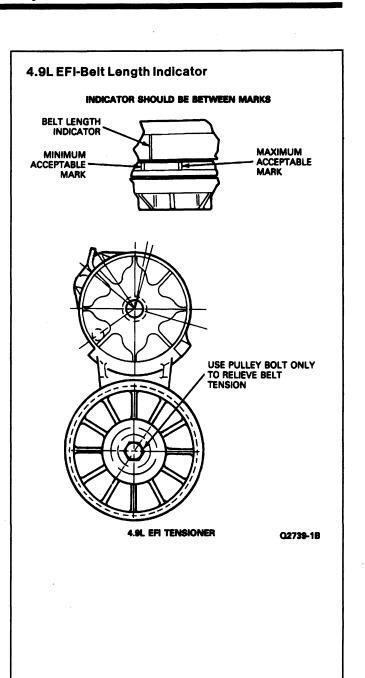
## **Belt Tension—Manually Tensioned Belts**

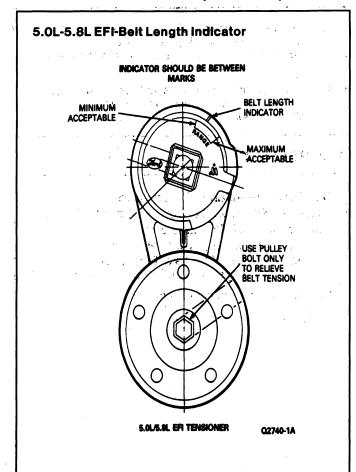
Use a Standard ''V" Belt Tension Gauge T63L-8620-A or equivalent for ''V" Belts, or a standard ''poly V" belt tension gauge 021-00019 or equivalent for ''poly V" belts. Tension measurements should be taken at midspan. Refer to Specifications chart for the correct belt tensions.

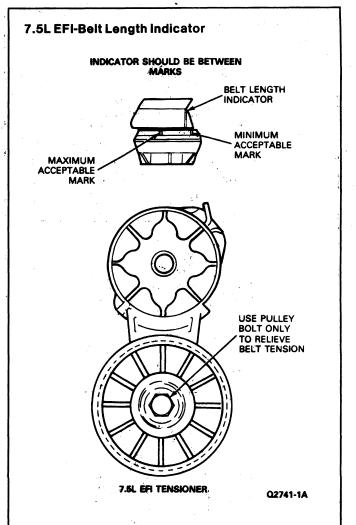


## **Belt Tension—Automatically Tensioned Belts**

The automatic belt tensioner will maintain correct belt tension if the correct length belt is on the engine. To verify that the tensioner is working properly check to see that the belt length indicator mark on the tensioner is between the maximum and minimum marks.

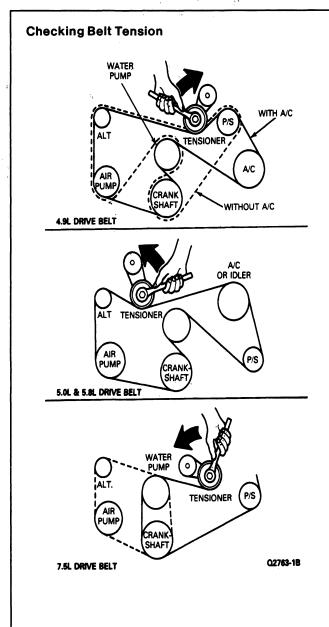






The belt tension can be checked as follows:

 Install a 5/8 in. or 16 mm wrench on the tensioner pulley bolt and rotate the tensioner arm to relieve all tension from the belt. Slowly return arm to rest against the belt and measure belt tension.



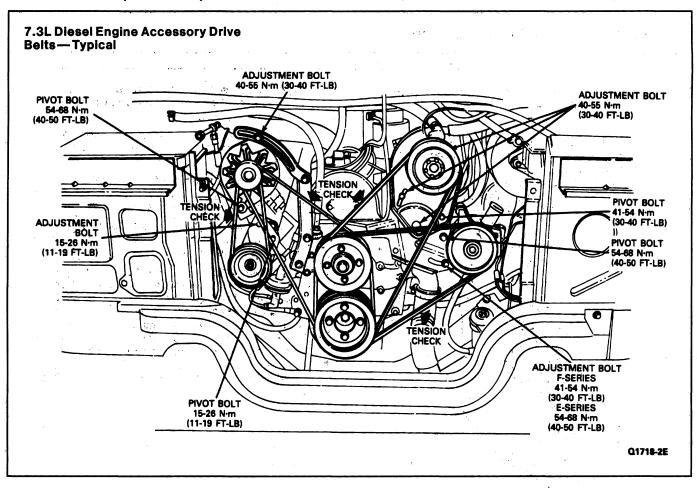
- Rotate arm against belt causing the pulley to deflect approximately 1/2 inch from its rest position. Slowly release tension from arm and measure belt tension.
- Average the two tensions and verify that result is above the minimum tension shown in Specifications chart.

## **ADJUSTMENTS**

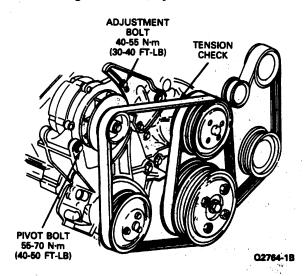
# Belt Tension—Manually Tensioned Belts—F-Series and E-Series with 7.3L Diesel Engine and 7.5L Gasoline Engine

- Use Belt Tension gauge T63L-8620-A or equivalent for "V" belts or Belt Tension Gauge 021-00019 or equivalent for "poly V" belts.
- 2. Loosen accessory adjustment bolts.

## **ADJUSTMENTS (Continued)**







 Tighten pivot bolt enough to remove all freeplay from pivot area but not enough to prevent the accessory from rotating to allow belt tensioning.  All Belts except Alternator Belt—Insert a square drive ratchet wrench or breaker bar in the square hole in accessory bracket and tighten belt to correct tension.

Alternator Belt—Place a "C" clamp over the end of the adjusting arm and the adjusting bolt boss and tighten belt to correct tension.

Be sure to use the "New Belt Tension" for new belts and the "Used Belt Tension" for used belts. A used belt is a belt with more than 5 minutes of engine operation. See "Accessory Drive Belt Tension" chart.

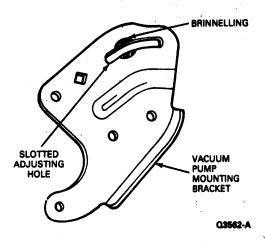
- Tighten adjustment bolt to specification while maintaining belt tension.
- 6. Remove square driver tool or "C" clamp.
- 7. Tighten pivot bolt to specification.
- 8. Check and readjust belt tension if necessary.
- 9. Start engine and idle for 5 minutes.
- 10. Recheck belt tension.
- 11. If tension is less than the "Minimum Tension After 5 Minutes Operation" from the table, then reset belt tension to within "Used Belt Tension" limits. Start engine and idle for 5 minutes. Recheck belt tension.

## **ADJUSTMENTS (Continued)**

12. If belt will not hold tension, then replace belt.

## Belt Tension—Alternator and Vacuum Pump Belt on 7.3L Diesel Engine—Ambulance Models

Remove the bolts at the pivot and adjusting locations of the vacuum pump mounting bracket. Prior to replacing the bolts with the new bolts with built in conical washers, part number N606688-S2, inspect the vacuum pump mounting bracket under the head of the bolts. If a noticeable amount of brinnelling is evident on the slotted hole of the vacuum pump mounting bracket under the head of the bolt the bracket and bolts should be replaced.



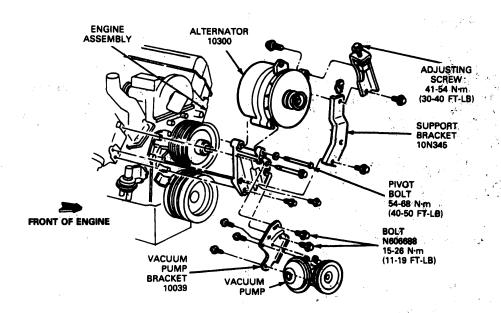
Install bolts with conical washers at the pivot and adjusting hole locations of the vacuum pump mounting bracket.

NOTE: The conical washer built into the bolt provides increased bearing surface and better clamp load on the bracket.

 Prior to setting tension on the alternator belt, loosen the vacuum pump mounting bracket at the pivot and the adjusting locations.

NOTE: Tightening the alternator belt while the vacuum pump is tight may severely over-tension the vacuum pump belt.

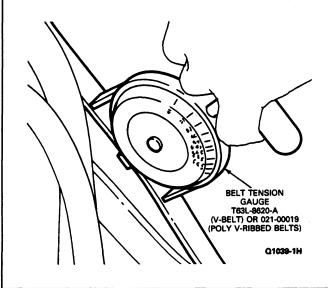
4. When adjusting the various brackets, the belt tension setting is sensitive to the bolt tightening sequence. In all cases, the pivot bolt should be tightened first and the adjusting bolt (the one through the slotted hole) should be tightened second. Tighten the vacuum pump pivot bolt and adjusting bolt to 15-26 N·m (11-19 ft-lb). Tighten the alternator pivot bolt to 54-68 N·m (40-50 ft-lb) and the adjusting bolt to 41-54 N·m (30-40 ft-lb).



Q3563-A

## ADJUSTMENTS (Continued)

- 5. If a new alternator belt is being installed, the tension must be reset after five minutes of engine operation. The tension on the new belt will tend to decrease as the belt flexes and seats into the pulley. Refer to the Specifications portion of this section for proper belt tension.
  - NOTE: Retensioning of the alternator belt will require loosening the vacuum pump bracket and resetting the vacuum pump belt tension after the alternator belt tension has been reset.
- 6. If a new vacuum pump belt is being installed, the tension must be reset after five minutes of engine operation. Refer to the Specifications portion of this section for proper belt tension. The vacuum pump belt tension is particularly sensitive to the bolt tightening sequence. Remember to tighten the pivot bolt first and then the adjusting bolt.
- 7. The alternator has a built in jack screw to facilitate adjustment. Use hand tools to make the adjustent. In all cases use of a tension gauge when setting the tension is required for proper operation of the belts. Tension measurements should be taken at mid-span. Several measurements should be taken, moving up and down the span to avoid an erroneous measurement which might occur on a seam of the belt material.



## **Power Steering Pulley Alignment**

A "chirping" noise from the accessory drive belt that is more noticeable at idle than at higher speeds may be caused by a power steering pump pulley that is out of alignment.

The misaligned pulley causes the accessory drive belt to "chirp" as it enters into either the power steering pulley or the pulley immediately down stream from the power steering pulley. Verify that the chirping noise is coming from the entrance to one of these two pulleys by listening through a length of rubber hose or other type of stethoscope like device.

If the chirp has been isolated to one of these pulleys then to correct this condition align the power steering pump pulley using the following service procedure.

CAUTION: Do not sand the edges of the drive belt or apply lubricants or dressings. These are only temporary fixes and may damage belt.

- Clean the accessory drive belt with mild soap and water to wash away belt dressing or other contaminants.
- On some models, it may be necessary to remove the fan shroud to allow for proper installation and operation of the power steering pulley puller and installer tools.
  - CAUTION: Damaged accessory drive belts should be replaced before proceeding to Step 4. Only use a 16mm closed end wrench to lift the belt tensioner to avoid possible damage. A wedged screwdriver will crack the pulley or crack the housing.
- Using Rotunda tools T69L-10300-B (puller) and T65P-3A733-C (installer), set the power steering pump pulley hub to within ±.010 inch of being flush with the end of the power steering pump shaft.
- Operate the engine at idle for five (5) minutes to see if "chirping" noise has been corrected. If not, proceed to Step 5.
- 5. Select a direction and move the power steering pump pulley at .020 inch INCREMENTS in that direction. After each move (increment), remove the tool and operate the engine for five (5) minutes: if "chirp" fades, alignment is being achieved; if "chirp" increases reverse the alignment direction.
- 6. Reinstall the fan shroud.

NOTE: ACCESSORY DRIVE BELT "CHIRP"
NOT CORRECTED BY THIS PROCEDURE MAY
BE CAUSED BY A DAMAGED PULLEY OR BENT
ACCESSORY SHAFTS. STEADY PULSATION
OF THE BELT TENSIONER PULLEY INDICATES
THIS CONDITION. OBSERVE EACH PULLEY IN
THE SYSTEM FOR RUNOUT.

## **Belt Tension—Automatically Tensioned Belts**

The automatic belt tensioner has no provision for adjustment and will be damaged if forced to travel beyond its operating range.

## **REMOVAL AND INSTALLATION**

#### **Accessory Drive Belts**

Conditions requiring belt replacement are excessive wear, severe glazing, frayed cords, etc. Replace any belt exhibiting any of these conditions.

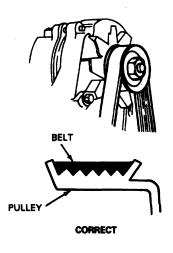
NOTE: Minor cracks in the ribbed side of the belt are considered acceptable.

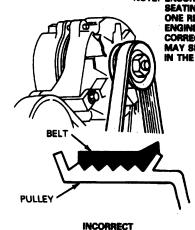
Proper removal and installation steps are as follows:

## **Automatically Tensioned Belts**

- Install a 5/8 inch or 16 mm closed end wrench on the tensioner pulley bolt and lift the tensioner arm away from the belt.
- Remove old belt. Release tensioner slowly. Do not allow tensioner to snap back after the belt is removed because this may damage the tensioner.
- Install new belt over pulleys making sure that all six belt ribs are correctly seated in the pulley grooves.

## **Ribbed Belt Alignment**



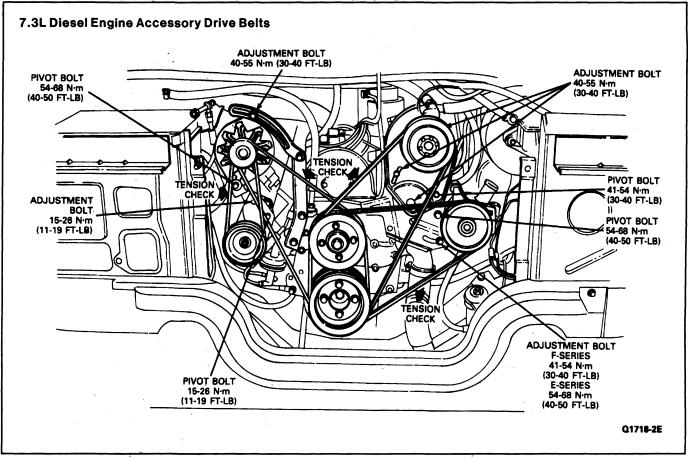


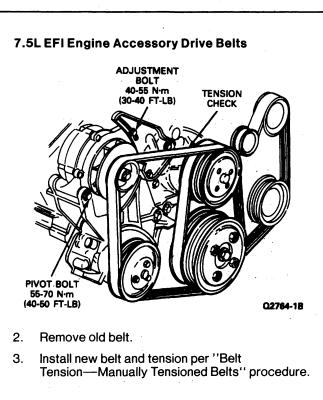
NOTE: ENSURE CORRECT
SEATING ON ALL PULLEYS.
ONE REVLUTION OF THE
ENGINE WITH AN INCORRECTLY SEATED BELT
MAY SNAP TENSILE MEMBERS
IN THE BELT

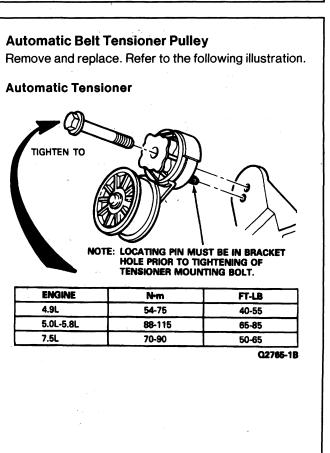
Q1696-2C

## **Manually Tensioned Belts**

 Loosen accessory adjustment bolts and pivot bolt as shown in the following illustrations.







## **Belt Tensioner Pulley Replacement**

| Engine    | Tensioner                                       | Replacement Pulley |
|-----------|---|--------------------|
| 5.0L/5.8L | E8TA-6B209-AA<br>E8TA-6B209-BA                  | E9TA-19A216-AA     |
| 4.9L/7.5L | E7TA-6B209-HB<br>E7TA-6B209-CB<br>E7TA-6B209-FC | E9TA-19A216-BA     |

CQ1808-1A

Conditions requiring pulley replacement are excessive pulley wear or pulley bearing noise usually resulting from extended operation in abrasive off-road conditions.

Using a 16mm closed end wrench, remove the drive belt per the "Automatically Tensioned Belt" removal procedure in this Section.

Using the same wrench, loosen the idler pulley retention bolt.

NOTE: 5.0L, 5.8L and 7.5L bolts have a LH thread, requiring clockwise motion to loosen. 4.9L idler pulley bolts have a conventional RH thread which loosens counterclockwise.

NOTE: Excessive rearward force on the bolt during removal may over stress and crack the tensioner arm.

Remove bolt and dust shield and remove the pulley from the tensioner arm locating boss.

NOTE: Pulleys being replaced for suspected bearing wear should be evaluated for rough bearings. Bearing noise which continues or rapidly returns after a replacement pulley is installed is usually belt "chirp" rather than worn bearings. Bearings should rotate smoothly with a slight resistance due to the permanent lubrication.

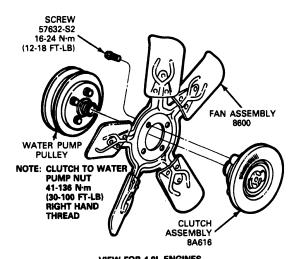
Replace the pulley and reverse the removal instructions observing the correct rotation of the retention bolt. Tighten bolt to 75-88 N·m (55-65 ft-lbs).

## Fan and Viscous Clutch—4.9L EFI Removal

- Remove the fan shroud. Refer to Section 03-03, 1. Radiators.
- Remove the clutch assembly from the water pump by turning the large nut, which is part of the clutch, using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D or equivalents.

**CAUTION: This nut has a RIGHT-HAND thread** and must be rotated counterclockwise to remove it.

- 3. Remove the fan and clutch assembly.
- 4. If the fan and clutch have to be separated, remove the remaining bolts attaching the fan to the clutch.



**VIEW FOR 4.9L ENGINES** 

Q1519-J

#### Installation

- Install all of the bolts attaching the fan to the clutch. Tighten all bolts to 16-24 N·m (12-18 ft-lb).
- Install the fan / clutch assembly on the water pump hub by turning the large nut, which is part of the clutch, using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D or equivalents.

**CAUTION: This nut has a RIGHT-HAND thread** and must be rotated clockwise to tighten it.

Tighten to 41-136 N·m (30-100 ft-lb).

Install the fan shroud. Refer to Section 03-03. Radiators.

## Fan and Viscous Clutch—5.0L, 5.8L and 7.5L **Engines**

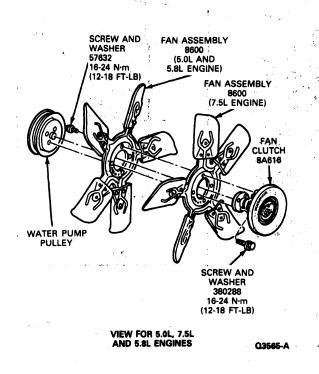
#### Removal

- Remove shroud and radiator if necessary. Refer to Section 03-03, Engine Cooling.
- 2. Remove four screws retaining clutch on water pump hub.
- Pull clutch and fan assembly off water pump pilot and remove assembly from vehicle.
- 4. Remove four screws and separate clutch from fan.

#### Installation

- Position fan to clutch assembly and attach with four screws. Tighten screws to 17-24 N·m (12-18 ft.-lb).
- Position fan and clutch assembly to water pump pulley and attach with four screws. Tighten screws to 16-24 N·m (12-18 ft-lb).

3. Install the fan shroud. Refer to Section 03-03, Radiators.

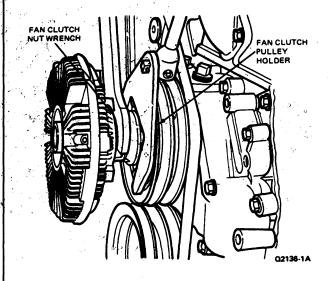


## Fan and Viscous Clutch—7.3L Diesel Removal

- Remove the fan shroud. Refer to Section 03-03, Engine Cooling.
- Remove the clutch assembly from the water pump shaft by turning the nut, which is part of the clutch, using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents.

## CAUTION: This nut has a LEFT-HAND thread and must be rotated clockwise for removal.

- 3. Remove the fan and clutch as an assembly.
- 4. Remove the bolts attaching the fan to the clutch, if necessary.



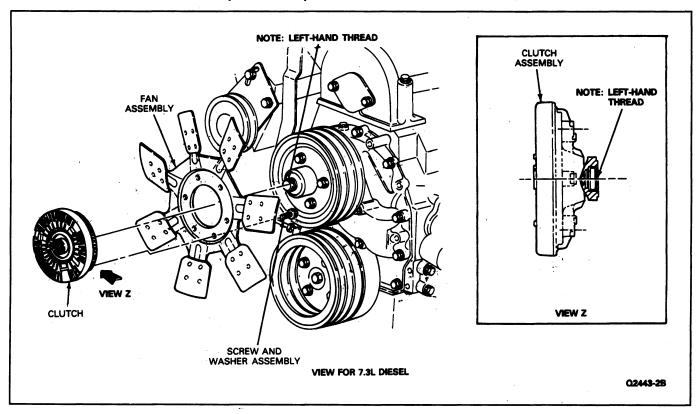
#### Installation

- 1. Install the bolts attaching the fan to the clutch. Tighten to 17-24 N·m (12-18 ft-lb).
- Install the clutch/fan assembly on the water pump by turning the large nut which is part of the clutch.

CAUTION: This nut has a LEFT-HAND thread and must be rotated counterclockwise for tightening.

Tighten to 54-163 N·m (40-120 ft-lb) using Fan Clutch Holding Tool T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents.

3. Install the fan shroud. Refer to Section 03-03, Engine Cooling.



## **SPECIFICATIONS**

#### **ACCESSORY DRIVE BELT TENSION**

| Tensioning New Belt Tension Engine Method Belt Type (0 Min. Operation) |                                 | Used Belt Tension<br>(Greater Than 5 Min.<br>Operation) | Min. Tension<br>After 5 Min.<br>Operation       |                         |                 |
|--|---------------------------------|---|---|-------------------------|-----------------|
| 4.9L   | Automatic                       | 6K "poly V" belt  | Tension OK if tensioner within indicator marks. | Same as new             | Same as new     |
|  |                                 |   | 60A/75A 400 N (90 lb.) min.                     |                         | ·               |
|  | <u> </u>                        |   | 100A 520 N (117 lb.) min.                       |                         |                 |
| 5.0L<br>5.8L   | Automatic                       | 6K "poly V" belt  | Tension OK if tensioner within indicator marks. | Same as new             | Same as new     |
|  |                                 |   | 60A/75A 343 N (77 lb.) min.                     |                         |                 |
|  |                                 |   | 100A 494 N (111 lb.) min.                       |                         |                 |
| 7.3L<br>(F-Series<br>and<br>E-Series)                                  | Manual                          | Vac. Pump "V" belt<br>9.5 mm (3/8 in)                   | 400-578 N (90-130 lb.)                          | 289-378 N (65-85 lb.)   | 267 N (60 lb.)  |
|  |                                 | Vac. Pump "V" belt<br>12.7 mm (1/2 in.)                 | 489-667 N (110-150 lb.)                         | 334-423 N (75-95 lb.)   | 311 N (70 lb.)  |
|  |                                 | All Other "V" belt<br>12.7 mm (1/2 in)                  | 622-800 N (140-180 lb.)                         | 423-511 N (95-115 lb.)  | 400 N (90 lb.)  |
| 7.3L   | Manual                          | Alternator "V" belt                                     | 622-711 N (140-160 lb.)                         | Same as New             | Same as New     |
| (Ambulance<br>Models)  | 1                               | Vac. Pump "V" belt                                      | 400-578 N (90-130 lb.)                          | 289-378 N (65-85 lb.)   | 267 N (60 lb.)  |
| WOODIS)  |                                 | Air Cond. and Power Steering "V" belt                   | 622-800 N (140-180 lb.)                         | 422-512 N (95-115 lb.)  | 400 N (90 lb.)  |
| 7.5L   | (A/C & P/S belt)<br>Automatic   | 6K "poly V" belt  | Tension OK if tensioner within indicator marks. | Same as new             | Same as new     |
|  |                                 |   | 418 N (94 lb.) min.                             |                         |                 |
|  | (Alt & Air Pump<br>belt) Manual | 6K "poly V" belt  | 711-889 N (160-200 lb.)                         | 489-578 N (110-130 lb.) | 467 N (105 lb.) |

CQ2766-C

## **SPECIAL SERVICE TOOLS**

| Tool Number | Description                   |
|-------------|-------------------------------|
| T63L-8620-A | Standard V-Belt Tension Gauge |
| T84T-6312-C | Fan Clutch Holding Tool       |
| T84T-6312-D | Fan Clutch Nut Wrench         |
| T83T-6312-A | Fan Clutch Pulley Holder      |
| T83T-6312-B | Fan Clutch Nut Wrench         |

## **ROTUNDA EQUIPMENT**

| Model No. | Description                      |
|-----------|----------------------------------|
| 021-00019 | Poly V-Ribbed Belt Tension Gauge |
|           | CQ2743-1E                        |
|           |                                  |

## SECTION 03-06A Starter—Positive Engagement

| SUBJECT PAG                      | E SUBJECT    | PAGE     |
|----------------------------------|--------------|----------|
| DESCRIPTION AND OPERATION03-06A- |              | . 1      |
| DIAGNOSIS AND TESTING            | Road Service | 03-06A-2 |
| Bench Tests03-06A-               |              |          |
| Diagnosis Guide03-06A-           |              |          |
| Jump Starting03-06A-             |              |          |
| On Vehicle Testing03-06A-        |              |          |
|                                  |              |          |

#### **VEHICLE APPLICATION**

Vehicles with Gasoline Engines

#### **DESCRIPTION AND OPERATION**

The starting system includes the starter motor with an integral positive-engagement drive, the battery, a remote control starter switch (part of the ignition switch), the neutral start switch (used with automatic transmissions), the starter relay, starter interlock switch (used with manual transmissions except F-Super Duty Commercial Stripped Chassis with manual transmission), and heavy circuit wiring.

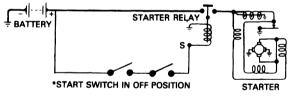
Turning the ignition key to the START position actuates the starter relay through the starter control circuit. The starter relay then connects the battery to the starter.

In the starter control circuit, vehicles equipped with an automatic transmission have a neutral start switch; while vehicles equipped with a manual transmission have a starter interlock switch. This prevents operation of the starter if the selector lever is not in the N (NEUTRAL) or P (PARK) position (automatic) or clutch depressed (manual).

When the starter is not in use, one of the field coils is connected directly to ground through a set of contacts. When the starter is first connected to the battery, current flows through the grounded field coil, actuating a movable pole shoe. The pole shoe is attached to the starter drive plunger lever and thus the drive is forced into engagement with the flywheel ring gear.

When the movable pole shoe is fully seated, it opens the field coil grounding contacts and the starter is then in normal operation. Normal field current is used to maintain the movable pole shoe in the fully seated position during the time that the starter is cranking the engine.

#### **Starting Circuit**



**NEUTRAL START SWITCH** 

J1083-1P

#### **DIAGNOSIS AND TESTING**

#### **Jump Starting**

The following instructions for starting the vehicle with jumper cables contain precautions that should be observed to avoid possible injury, or damage to the vehicle.

WARNING: KEEP BATTERIES OUT OF REACH OF CHILDREN. THEY CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES, OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF 15 MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

WARNING: HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

CAUTION: Use only a 12-volt jumper system. A 12-volt starting motor and ignition system can be damaged beyond repair by connecting it to a 24-volt power supply (two 12-volt batteries in series, or a 24-volt motor generator set).

CAUTION: Follow procedure in exact sequence.

CAUTION: Filament failures of headlamps can occur when vehicle with a dead battery is jump started. Place the main light switch in OFF position.

### CAUTION: Do not allow vehicles to touch.

- 1. Turn all lamps off before and during jump starting.
- Turn on heater blower motor to remove transient voltage.
- Shield eyes. Use safety goggles or similar eye protection.
- Connect end of one cable to positive (+) terminal of discharged battery and the other end to the positive (+) terminal of the "good" battery.

#### **Jump Starting Gasoline Engine**

BATTERY

GASOLINE ENGINE

J2571-1D

ENSURE VEHICLES DO NOT TOUCH

 Connect one end of the other cable to negative (-) terminal of "good" battery.

DISCHARGED

- Connect other end of cable to engine bolthead or similar good contact spot on the vehicle being started (NOT to negative (-) terminal of battery).
- Ensure jumper cables are not in way of moving engine parts. Start engine of vehicle with good battery. Run engine at a moderate speed. Start engine of vehicle with discharged battery. Reduce engine speed to idle on both vehicles to prevent possible damage to vehicle electrical systems.
- Remove cable from engine block first, then other end of negative cable. Disconnect cable from battery positive terminal of good battery before disconnecting positive cable from discharged battery. Lamps may now be turned on.

#### **Road Service**

On road service calls or cases of a starter that will not crank the engine or a starter that cranks very slowly, a booster battery may be connected to the 12-volt system. If the engine still will not turn with the booster connected, refer to the following tests:

#### On Vehicle Testing

#### If Starter Cranks Slowly

- BATTERY—Use jumper cables per instructions.
   If this corrects the problem, check condition of
   battery. Recharge or replace if necessary. Clean
   battery posts, cable lugs and tighten. Refer to
   Section 14-01, Batteries for battery service
   procedures.
- CABLES—If step 1 does not correct problem, clean and tighten connections at starter, relay and battery ground on engine. Eyelet terminals should not be easily rotated by hand. Also, check for short to ground.

STARTER—If above steps do not correct problem, remove starter.

#### If Starter Does Not Crank But Starter Relay **Operates (Clicks)**

- BATTERY—Use jumper cables, check battery, etc., as above.
- CABLE—Clean and tighten connections at 2. starter, engine ground and relay. Ensure wire strands are secure in eyelets.
- STARTER—If above steps do not correct problem, remove starter and perform bench tests to determine cause of problem. Repair or replace as required.

#### If Starter Does Not Crank and Relay Chatters Or **Does Not Click**

- BATTERY—Use jumper cables, check battery, etc. as above.
- 2. RELAY—Remove push-on connector from relay (red w/blue stripe wire). Ensure connection is clean and secure. Ensure relay bracket is grounded.

#### WARNING: Set parking brake.

If connections are good, check operation by jumping with push-on connection off and transmission in PARK or NEUTRAL. Jumper above described terminal to relay main terminal (BAT side) or battery positive post. If this corrects problem, check ignition switch, neutral switch or clutch interlock switch and wiring in start circuit for open of loose connections.

**Starter Load Test** 

- If jumper across relay does not correct problem, replace relay.
- CABLE—Clean and tighten connections at starter, engine ground and relay. Ensure wire strands are secure in eyelets.

#### If Starter Spins (Humming Noise) But Does Not **Crank Engine**

STARTER—Remove and check armature shaft for corrosion. Clean or replace. If no corrosion, repair starter or replace starter drive.

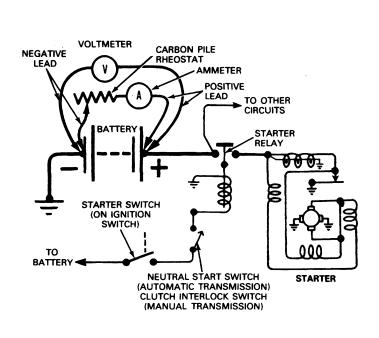
#### **Starter Load Test**

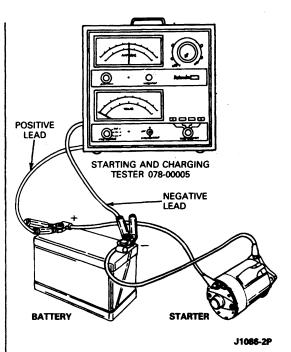
Conduct this test if the starter cranks slowly and a comparison of the current output with specifications is desired.

Connect the test equipment as shown. Ensure no current is flowing through the ammeter and heavy-duty carbon pile rheostat portion of the circuit (rheostat at maximum counterclockwise position).

With transmission in PARK or NEUTRAL, crank the engine with the ignition OFF, and determine the exact reading on the voltmeter. This test is accomplished by disconnecting the push-on connector "S" at the starter relay and by connecting the remote control starter switch from the positive battery terminal to the "S" terminal of the starter relay.

Stop cranking the engine. Then, reduce the resistance of the carbon pile until the voltmeter indicates the same reading as that obtained while the starter cranked the engine. The ammeter will indicate the starter current draw under load. Refer to Specifications.





#### **Bench Tests**

#### **Starter No-Load Test**

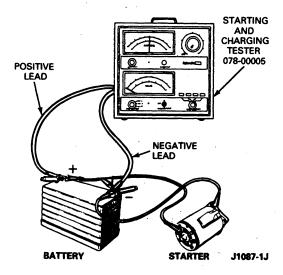
The starter no-load test will uncover open or shorted windings, rubbing armature, and bent armature shaft. The starter can be tested, at no-load, on the test bench only.

# CAUTION: Secure starter to vise or fasten securely in similar fixture as starter generated torque may propel starter off bench.

Make the test connections as shown, using a Rotunda 078-00005 Starting and Charging Tester. The starter will run at no-load. Ensure no current is flowing through the ammeter (rheostat at maximum counterclockwise position). Determine the exact reading on the voltmeter.

Disconnect the starter from the battery. Then, reduce the resistance of the rheostat until the voltmeter indicates the same reading as that obtained while the starter was running. The ammeter will indicate the starter no-load current draw. Refer to Specifications.

#### **Starter No-Load Test on Test Bench**



#### **Armature Open Circuit Test**

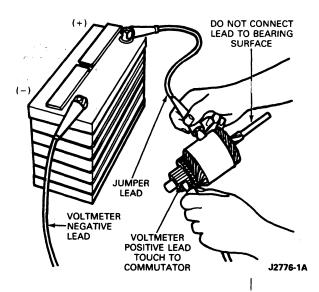
An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit winding, passes under a brush.

#### **Armature and Field Grounded Circuit Test**

This test will determine if the winding insulation has been damaged, permitting a conductor to touch the frame or armature core.

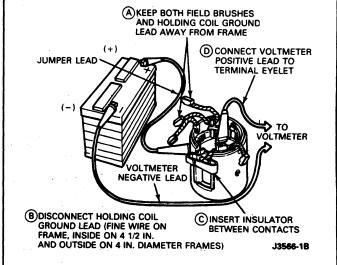
To determine if the armature windings are grounded, make the connections as shown. If the voltmeter indicates any voltage, the windings are grounded.

#### **Armature Grounded Circuit Test**



Grounded field windings can be detected by making the connections as shown. If the voltmeter indicates any voltage, the field windings are grounded.

#### **Field Grounded Circuit Test**



#### Diagnosis Guide

Use the following Diagnosis Guide to assist in locating the possible cause of any starter complaint that may occur.

| CONDITION   | POSSIBLE CAUSE  | RESOLUTION   |
|---|---|--|
| Engine will not crank.  | Loose, corroded, or broken cables or connectors.  | Clean and tighten cable connections     — check wire strands in eyelets.     Replace if necessary.   |
|   | 2. Undercharged battery.  | 2. Check battery. Charge or replace.   |
|   | Burned fusible link in main wire feed to ignition switch.   | Check fusible link and replace if necessary.   |
|   | 4. Starter relay (Gasoline Engine only)   | 4. Check all connections and mounting screws. With transmission in PARK of NEUTRAL, connect a jumper from the small terminal of the starter relay to the battery. If this jumper activates starter, check wiring to relay, ignition switch, neutral switch or clutch interlock switch for open or loose connections. If relay is not activated by jumper, replace relay. |
|   | Loose, corroded or open wiring —     ignition switch, neutral switch, solenoid     or auxiliary switch. | Clean and tighten connections or<br>replace wiring. Replace switches if<br>necessary.  |
|   | 6. Starting motor.  | 6. Repair or replace as required.  |
| Engine will not crank — starter relay or auxiliary switch clicks. | Loose cable connections at relay, switch or starter.  | Clean and tighten cable connections – check wire strands in eyelets.   |
|   | Undercharged battery.   | 2. Check battery. Charge or replace.   |
|   | 3. Starting motor.  | 3. Repair or replace as required.  |
| Engine will not crank — starter spins.                            | 1. Starting motor.  | Remove starter and inspect drive for<br>worn clutch. Replace as required.  |
|   | 2. Flywheel ring gear.  | Remove starter and inspect ring gear teeth (also starter drive pinions). Replace as required.  |
| Engine cranks continuously with key off.                          | Starter relay or auxiliary switch.  | Replace starter relay or auxiliary switch.   |
| Engine cranks slowly.   | Loose connections or corroded battery cables.   | Clean and tighten cable connections.   |
|   | 2. Undercharged battery.  | 2. Check battery. Charge or replace.   |
|   | 3. Starting motor.  | 3. Repair or replace as required.  |

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## **REMOVAL AND INSTALLATION**

#### Removal

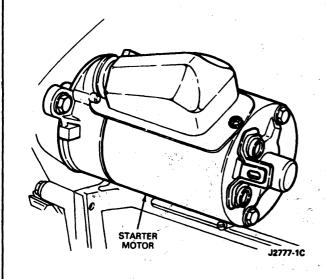
- 1. Disconnect negative battery cable.
- 2. Raise vehicle on a hoist.
- 3. Disconnect starter cable at starter terminal.
- 4. Remove starter mounting bolts. Remove starter assembly.

## Installation

- Position starter assembly to flywheel housing, and start mounting bolts.
- Snug all bolts while holding starter squarely against its mounting surface and fully inserted into pilot hole. Tighten bolts to 21-27 N·m (15-20 ft-lb).
- 3. Connect starter cable.

 Lower vehicle. Connect negative battery cable to battery. Check operation of starter.

#### **Starter Mounting**

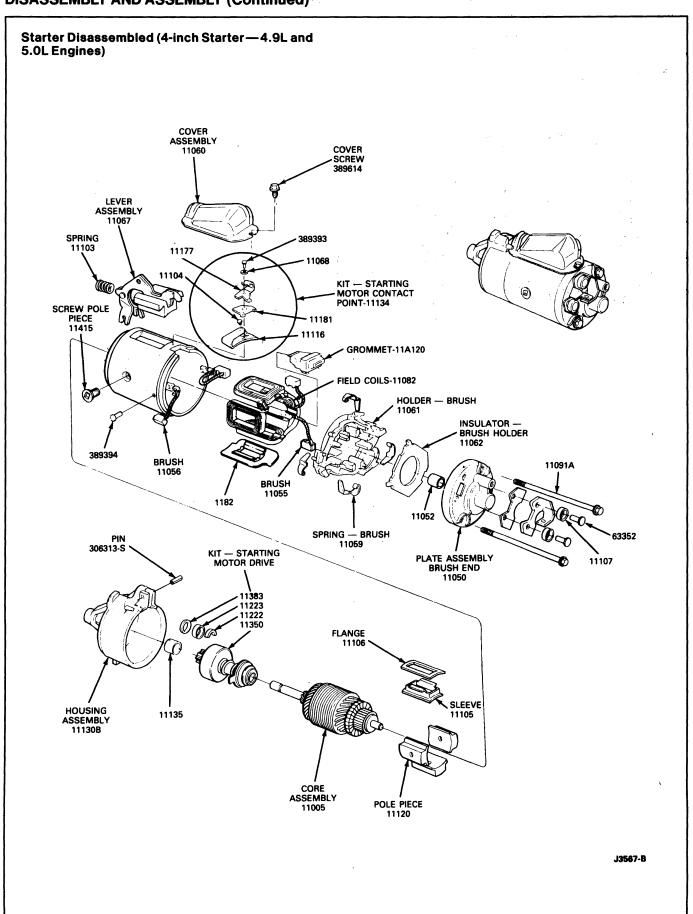


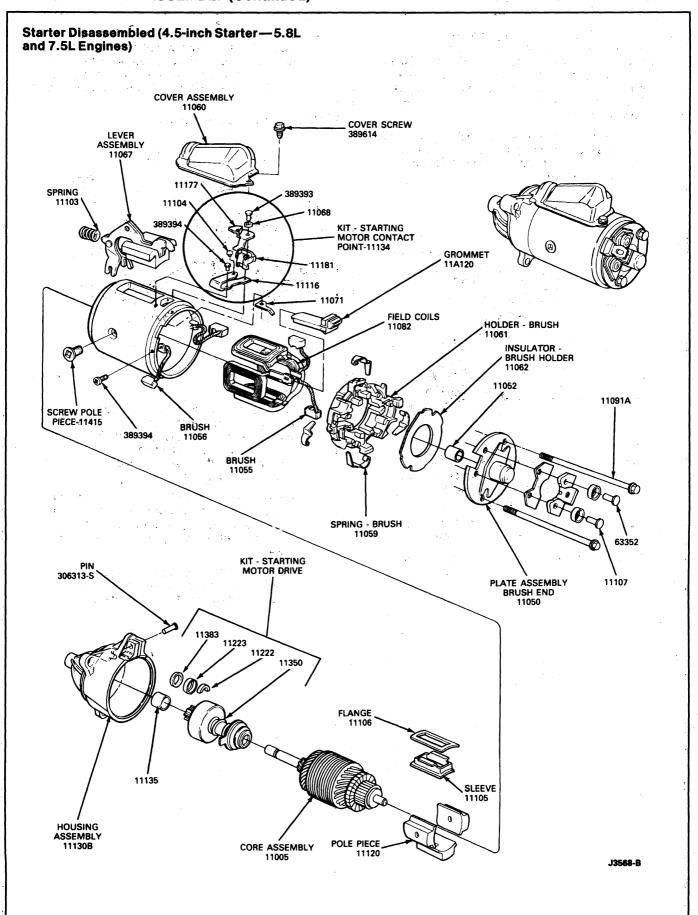
## DISASSEMBLY AND ASSEMBLY

Use the following procedure when it becomes necessary to completely overhaul the starter.

#### Disassembly

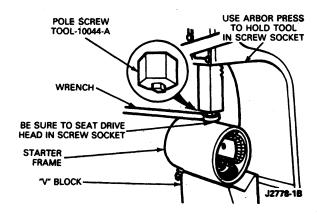
- 1. Remove cover screw and cover.
- Remove the pivot pin retaining starter plunger lever. Remove through-bolts, the starter drive end housing, and lever return spring. Remove plunger lever and armature.
- Remove thrust washer and stop ring retainer.
   Remove and discard stop ring retaining starter drive to end of the armature shaft, and remove starter drive assembly.
- 4. Remove brush end plate and insulator assembly.
- Remove brushes from plastic brush holder and lift out brush holder. Note location of brush holder with respect to end terminal.
- 6. Remove two screws retaining ground brushes to frame. (Four-inch starter has copper rivets.)
- On field coil that operates starter drive gear actuating lever, bend edges on field coil retaining sleeve and remove sleeve and retainer.





- Remove three coil retaining screws using an arbor press. The arbor press prevents the wrench from stripping out head of screw. Cut the field coil connection at the switch post lead and remove small diameter ground wire from upper tab riveted to frame. Remove pole shoes and coils from frame.
- Cut positive brush leads from field coils, as close to the field connection point as possible, if replacement is necessary. Refer to Step 5 of Cleaning and Inspection.

#### **Pole Shoe Screw Removal**

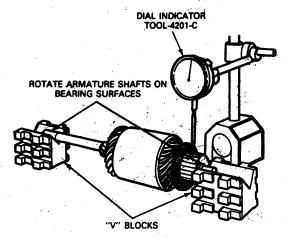


### Cleaning and Inspection

- Use a brush or air to clean the field coils, armature, commutator, armature shaft, brush end plate, and drive end housing. Wash all other parts in solvent and dry the parts.
- 2. Inspect armature windings for broken or burned insulation and unsoldered or open connections.
- 3. Check armature for open circuits and grounds.

 Check commutator for runout using Dial Indicator TOOL-4201-C or equivalent. Inspect armature shaft and two bearings for scoring and excessive wear. If the commutator is rough or more than 0.127mm (0.005 inch) out-of-round, turn it down.

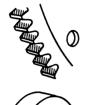
#### **Commutator Runout Check**

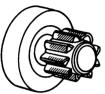


J2716-1B

- Check plastic brush holder for cracks or broken mounting pads. Replace brushes if worm to 6.35mm (1/4 inch) in length. Check field brush connections. A brush kit and contact kit are available. All other assemblies are to be replaced rather than repaired.
- Examine wear pattern on starter drive teeth. The pinion teeth must penetrate to a depth greater than one-half the ring gear tooth depth to eliminate premature ring gear and starter drive failure.
- Replace starter drives and ring gears having milled, pitted or broken teeth or that show evidence of inadequate engagement.

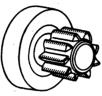
## **Pinion and Ring Gear Wear Patterns**



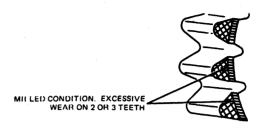


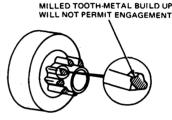






SMALL WEAR PATTERN





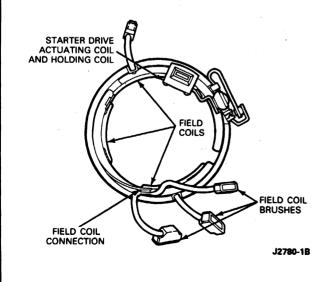
MILLED GEARS

J1372-2C

## **Assembly**

- Position the three coils and pole pieces, then install attaching screws. As the pole shoe screws are tightened, strike the frame several sharp blows with a soft-faced hammer to seat and align the pole shoes.
- 2. Install remaining coil and retainer and bend tabs to secure coils to frame.

#### Field Coil Assembly



- Position new insulated field brush lead on field coil terminal. Install clip provided with brushes to hold brush lead to terminal. Solder lead, clip, and terminal together using rosin core solder. Use a 300-watt iron.
- Check for continuity and grounds in assembled coils.
- The coil which is around retaining sleeve is to be grounded by positioning small diameter wire leading from it, under copper tab held by the rivet which attaches contact to frame.
- Attach ground brushes to starter frame with screws. (Four-inch starter has copper rivets.)
- Apply a thin coating of Lubriplate 777 or equivalent on the armature shaft splines. Install starter motor drive assembly to armature shaft and install a new retaining stop ring. Install a new stop retainer and thrust washer.
- Install armature in starter frame.
- Partially fill drive end housing bearing bore with Grease ESB-M1C63-A or equivalent (approximately 1/4 full). Position starter plunger lever to the frame and starter drive.
- Position starter drive plunger lever return spring and drive end housing to frame. Install brush holder, and insert brushes and springs. Install brush holder insulator.

- Position end plate to frame. Install and tighten through bolts to 6.21-8.47 N·m (55-75 in-lb). Do not pinch brush leads when installing end plate. Install pivot pin.
- 12. Position drive plunger lever cover and fasten to frame with cover screw.
- 13. Check starter no-load current draw.

#### **Starter Drive Replacement**

- Remove starter plunger cover.
- 2. Remove pivot pin retaining starter plunger lever.
- Loosen through bolts enough to allow removal of drive end housing and lever return spring. Remove lever.
- Remove thrust washer, drive stop ring retainer and stop ring from end of armature shaft and remove drive assembly.
- Apply a thin coating of Lubriplate 777 or equivalent on armature shaft splines. Install drive assembly on armature shaft and install a new stop ring.
- Position starter gear plunger lever on the starter frame. Ensure lever properly engages drive flange.
- Install a new stop ring retainer and thrust washer. Partially fill drive end housing bearing bore with Grease ESB-M1C63-A or equivalent (approximately 1/4 full). Position lever return spring and drive end housing to starter frame. Tighten through bolts to 6.21-8.47 N·m (55-75 in-lb). Install pivot pin.
- 8. Position starter drive plunger lever cover on starter. Tighten attaching screw.

#### **Brush Replacement**

Replace starter brushes when they are worn to 6.35mm (1/4 inch). Always install a complete set of new brushes.

- 1. Remove the two through-bolts from starter frame.
- Remove brush end plate, brush springs and brushes from holder.
- 3. Remove ground brush attaching screws or rivets from frame and remove brushes.
- 4. Cut insulated brush leads from field coils, as close to field connection point as possible.
- Check plastic brush holder for cracks or broken mounting pads. Replace if necessary.
- Position new insulated field brush lead on field coil connection. Position and crimp clip provided with brushes to hold brush lead to connection. Solder lead, clip, and connection together using a 300-watt iron and rosin core solder.

- Install ground brush leads to frame with attaching screws or rivets.
- Install brush holder and insert brushes in holder.
   Install brush springs. Positive brush leads should be positioned in their respective slots in brush holder to prevent potential grounding.
- Install brush end plate. Ensure end plate insulator is positioned properly on end plate.
- 10. Install two through bolts to starter frame. Tighten to 6.21-8.47 N⋅m (55-75 in-lb).
- Secure starter in a vise. Connect starter to a battery to check its operation.

#### **Armature Replacement**

- Remove starter drive plunger lever cover retainer screw and remove cover.
- Remove pivot pin retaining starter plunger lever.
- Remove through bolts, drive end housing, plunger lever, drive plunger lever return spring, and brush end plate. Remove brushes and lift out brush holder.
- Remove armature. If starter drive assembly is being reused, remove stop ring from end of armature shaft, and remove drive.
- 5. Place drive assembly on new armature with a new stop ring, retainer and thrust washer.
- 6. Install armature in starter frame.
- Position drive plunger lever to frame and drive assembly. Ensure lever properly engages drive flange.
- Partially fill drive end housing bearing bore with Grease ESB-M1C63-A or equivalent (approximately 1/4 full). Position drive lever return spring, and drive end housing to starter frame. Ensure stop ring retainer is seated properly in drive housing.
- Install brush holder and insert brushes in holder. Install brush springs. Positive brush leads should be positioned in their respective slots to prevent grounding.
- 10. Install brush end plate. Ensure end plate insulator is positioned properly on end plate.
- Install two through bolts to starter frame. Tighten to 6.21-8.47 N·m (55-75 in-lb). Install pivot pin.
- 12. Install starter drive plunger lever cover and tighten retaining screw.
- Check starter no-load current draw with starter secure in vise during test.

## **SPECIFICATIONS**

|               |                 |                                      |                                    |      |                    | . 42      |         | *    |         |         |         |
|---------------|-----------------|--------------------------------------|------------------------------------|------|--------------------|-----------|---------|------|---------|---------|---------|
| Starter Motor |                 |                                      |                                    |      |                    |           |         |      | Starter | Brushes |         |
|               | lotor<br>ameter | Current Draw<br>Under Normal<br>Load | Normal Engine<br>Cranking<br>Speed |      | Stall<br>@ 5 Volts | Max. Load | No Load | Mfg. | Length  | Spring  | Tension |
| mm            | Inches          | Amps                                 | RPM                                | N-m  | Lb-Ft              | Amps      | Amps    | mm   | Inches  | N       | oz.     |
| 78            | 3               | 130-220                              | 100-230                            | 14.7 | 11.0               | 800       | 70±10   | 16.8 | 0.66    | 18      | 64      |

Maximum Commutator runout is 0.12mm (0.005 inch) Maximum starting circuit voltage drop (battery positive terminal to start terminal) at normal engine temperture is 0.5 volt.

## **SPECIAL SERVICE TOOLS**

| Tool No.     | Description               |
|--------------|---------------------------|
| TOOL-10044-A | Starter Pole Screw Wrench |
| TOOL-4201-C  | Dial Indicator            |

CJ4735-2A

#### ROTUNDA EQUIPMENT

| Model     | Description                  |
|-----------|------------------------------|
| 078-00005 | Starting and Charging Tester |
|           | A 10000 4E                   |

## SECTION 03-06B Starter—Gear Reduction

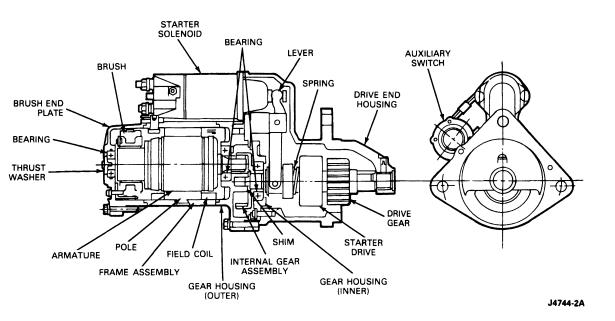
| SUBJECT PA                           | PAGE SUBJECT                   | PAGE                  |  |
|--------------------------------------|--------------------------------|-----------------------|--|
| ADJUSTMENTS                          | DIAGNOSIS AND TESTING          | DIAGNOSIS AND TESTING |  |
| Armature and Field Grounded Circuit  | Auxiliary Switch               | 03-06B-3              |  |
| Test03-06                            | 06B-5 Brush Holder             | 03-06B-3              |  |
| Armature Open Circuit Test03-06      | 06B-5 Diagnosis Guide          | 03-06B-3              |  |
| Performance Test (No-Load Test)03-06 | 06B-5 Field Coils              | 03-06B-3              |  |
| Pinion Gap03-06                      | 06B-5 Jump Starting            | 03-06B-2              |  |
| CLEANING AND INSPECTION              | Starter Solenoid               |                       |  |
| Armature Shaft and Commutator03-06   | 06B-8 DISASSEMBLY AND ASSEMBLY |                       |  |
| Bearings03-06                        | 06B-8 Starter Motor            | 03-06B-7              |  |
| Brush Holder and Brushes03-06        | 06B-8 OPERATION                | 03-06B-2              |  |
| Gears03-06                           | 06B-8 REMOVAL AND INSTALLATION |                       |  |
| Overrunning Clutch03-06              | 06B-8 Starter Motor            | 03-06B-6              |  |
| Pole Shoes03-06                      | 06B-8 SPECIAL SERVICE TOOLS    | 03-06B-9              |  |
| DESCRIPTION                          | 06B-1 VEHICLE APPLICATION      | 03-06B-1              |  |

## **VEHICLE APPLICATION**

Applies to Vehicles Equipped with 7.3L Diesel Engines

#### DESCRIPTION

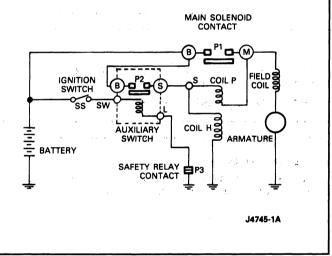
The Mitsubishi starter motor is a compact gear reduction type starter that utilizes an integral starter solenoid. With a gear reduction system, the starter motor can be relatively small and still provide the necessary torque to crank the engine.



#### **OPERATION**

When the ignition switch is closed, the contact (P2) in the auxiliary switch closes and the current flows through the auxiliary switch and through the safety relay contact to ground. When the P2 contact closes. current flows through contact P2 and out to coils P and H. As current flows in the coils of the switch, the plunger is pulled in and this causes the drive pinion to be pushed out into engagement with the flywheel ring gear. The current flowing through coil P causes the armature to rotate slowly. When the pinion has meshed completely with the ring gear, the main solenoid contact (P1) closes and allows battery voltage to pass to the starter motor, which now rotates at full speed. When the P1 contact is closed. no current flows in coil P and the solenoid plunger is held in by coil H.

When the ignition switch is opened (after engine start-up), contact P2 opens, causing main contact P1 to open and the starter motor disengages and stops. The drive pinion is pulled out of engagement with the flywheel by the return spring in the main solenoid.



#### DIAGNOSIS AND TESTING

#### **Jump Starting**

The following instructions for starting the vehicle with jumper cables contain precautions that should be observed to avoid possible injury, or damage to the vehicle.

WARNING: KEEP BATTERIES OUT OF REACH OF CHILDREN, THEY CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES, OR CLOT AING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF 15 MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

WARNING: HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

CAUTION: Use only a 12-volt jumper system. A 12-volt starting motor and ignition system can be damaged beyond repair by connecting it to a 24-volt power supply (two 12-volt batteries in series, or a 24-volt motor generator set).

**CAUTION:** Follow procedure in exact sequence.

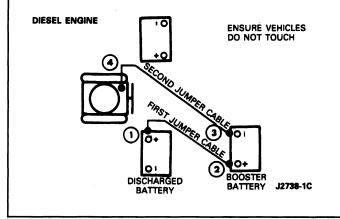
CAUTION: Filament failures of headlamps can occur when vehicle with a dead battery is jump started. Place the main light switch in OFF position.

CAUTION: Do not allow vehicles to touch.

- 1. Turn all lamps off before and during jump starting.
- Turn on heater blower motor to remove transient voltage.
- Shield eyes. Use safety goggles or similar eye protection.
- Connect end of one cable to positive (+) terminal of discharged battery and the other end to the positive (+) terminal of the "good" battery.
  - NOTE: For optimum power and safety, connect booster cable to battery on passenger side of vehicle to be started.
- 5. Connect one end of the other cable to negative (-) terminal of "good" battery.
- Connect other end of cable to engine bolthead or similar good contact spot on the vehicle being started (NOT to negative (-) terminal of battery).
- To prevent damage to other electrical components on vehicle being started, ensure that engine is at idle speed before disconnecting jumper cables.

## **DIAGNOSIS AND TESTING (Continued)**

 Remove cable from engine block first, then other end of negative cable. Disconnect cable from battery positive terminal of good battery before disconnecting positive cable from discharged battery. Lamps may now be turned on.



#### **Field Coils**

Test the field coils for an open circuit. There should be continuity through the coils.

Test the field coils for continuity to ground. There should be no continuity to ground between the field coil and the motor housing.

## **Brush Holder**

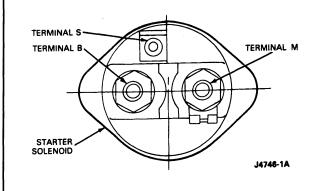
Check the insulated brush holder for continuity to the brush holder assembly. There should be no continuity.

#### **Starter Solenoid**

There should be continuity between the S and M terminals, and between S and ground.

There should be no continuity between the B and M terminals.

Inspect the main contact plate in the switch for excessive pitting.



## **Auxiliary Switch**

Check the auxiliary switch for continuity. If there is no continuity, the switch is open and must be replaced. Inspect the contacts for excessive pitting.

#### mapaciting contactor or crossor of pitting

#### **Diagnosis Guide**

Use the following Diagnosis Guide to assist in locating the possible cause of any starter complaint that may

## **DIAGNOSIS AND TESTING (Continued)**

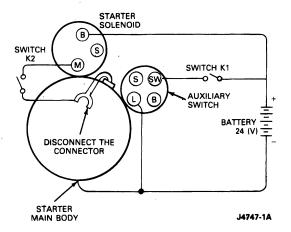
| CONDITION   | POSSIBLE SOURCE   | ACTION   |
|---|---|--|
| Engine will not crank.  | <ul> <li>Loose, corroded, or broken cables or connectors.</li> <li>Undercharged battery.</li> </ul>                       | <ul> <li>Clean and tighten cable<br/>connections—check wire strand<br/>in eyelets. Replace if necessary.</li> <li>Check battery. Charge or replace</li> </ul>  |
|   | Burned fusible link in main wire feed to ignition switch.   | Check fusible link and replace if necessary.   |
|   | <ul> <li>Starter relay (Gasoline Engines only)</li> </ul>   | <ul> <li>Check all connections and<br/>mounting screws. With<br/>transmission in PARK or<br/>NEUTRAL, connect a jumper from</li> </ul>   |
|   |   | the small terminal of the starter relay to the battery. If this jumper activates starter, check wiring to relay, ignition switch, neutral switch or clutch interlock switch for open or loose connections. If relay is not activated by jumper, replace relay. |
|   | Loose, corroded or open<br>wiring—ignition switch, neutral<br>switch, solenoid or auxiliary<br>switch.                    | <ul> <li>Clean and tighten connections or<br/>replace wiring. Replace switches<br/>if necessary.</li> </ul>  |
|   | <ul><li>Starting motor.</li><li>Clutch or neutral start switches.</li></ul>   | <ul><li>Repair or replace as required.</li><li>Repair or replace as required.</li></ul>  |
| Engine will not crank—starter relay or auxiliary switch clicks. | <ul> <li>Loose cable connections at relay,<br/>switch or starter.</li> <li>Undercharged battery.</li> </ul>               | Clean and tighten cable connections—check wire strand in eyelets.     Check battery. Charge or replace.  |
|   | Starting motor.   | Repair or replace as required.   |
| Engine will not crank—starter spins.                            | Starting motor.   | <ul> <li>Remove starter and inspect drive<br/>for worn clutch. Replace as<br/>required.</li> </ul>   |
|   | Flywheel ring gear.   | <ul> <li>Remove starter and inspect ring<br/>gear teeth (also starter drive<br/>pinions). Replace as required.</li> </ul>  |
| Engine cranks continuously with key off.                        | Starter relay or auxiliary switch.  | Replace starter relay or auxiliary switch.   |
| Engine cranks slowly.   | <ul> <li>Loose connections or corroded battery cables.</li> <li>Undercharged battery.</li> <li>Starting motor.</li> </ul> | <ul> <li>Clean and tighten cable connections.</li> <li>Check battery. Charge or replace</li> <li>Repair or replace as required.</li> </ul>   |

#### **ADJUSTMENTS**

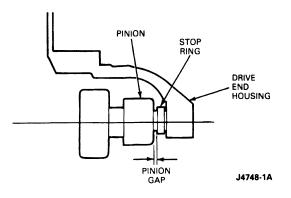
#### **Pinion Gap**

After the starter motor has been assembled, the pinion to drive end housing gap must be checked.

- 1. Mount the starter securely in a vise.
- Using two switches and a battery, connect the starter as shown.



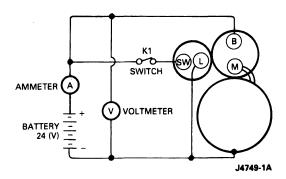
- When switches K1 and K2 are closed, the starter drive will be forced outward and the motor will turn. By opening switch K2, the starter will stop turning with the pinion in the full out position.
- 4. Check the pinion end gap in this position. End gap should be 0.1 2.5mm (.004 .100 inch).
- Adjust the end gap by changing the shims between the solenoid and the drive end housing. Increasing the shims will decrease the gap. Decreasing the shims will increase the gap.



#### Performance Test (No-Load Test)

After setting the pinion gap adjustment, check the no-load operation of the starter.

- 1. Mount the starter securely in a vise.
- Connect the starter as shown.



- 3. Close switch K1 to rotate the starter.
- 4. The starter is operating properly if it rotates smoothly and at an acceptable speed. If the starter rotates slowly, there may be insufficient clearance between the armature and the housing (determined by the shim behind the bearing in the end cover). Refer to Disassembly and Assembly for shim replacement.

NOTE: Due to the characteristics of gear reduction starters, the starter has a higher rotary sound than conventional starters.

## **Armature Open Circuit Test**

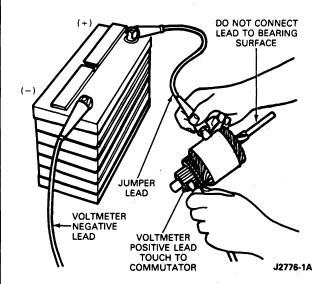
An open circuit may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit winding, passes under a brush.

### **Armature and Field Grounded Circuit Test**

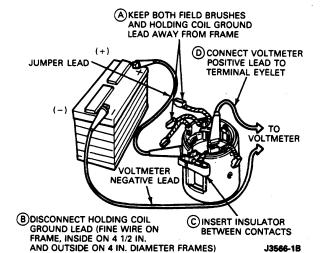
This test will determine if the winding insulation has been damaged, permitting a conductor to touch the frame or armature core.

## **ADJUSTMENTS (Continued)**

To determine if the armature windings are grounded, make the connections as shown. If the voltmeter indicates any voltage, the windings are grounded.



Grounded field windings can be detected by making the connections shown. If the voltmeter indicates any voltage, the field windings are grounded.



#### **REMOVAL AND INSTALLATION**

#### **Starter Motor**

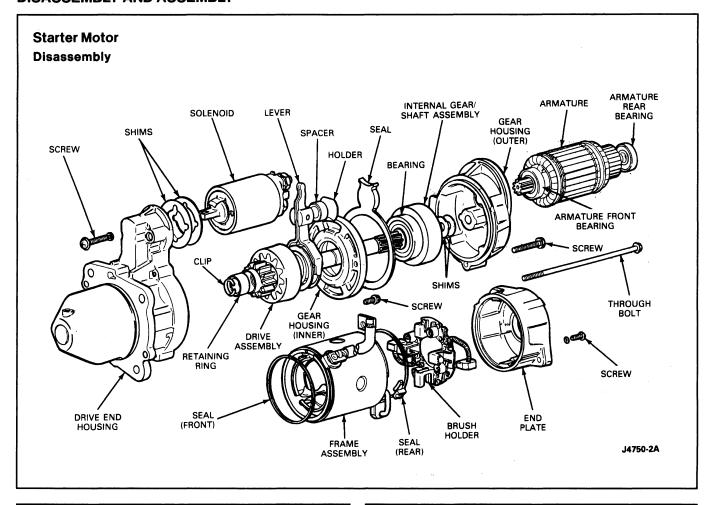
#### Removal

- 1. Disconnect the negative battery cable.
- 2. Raise the vehicle on a hoist.
- 3. Disconnect the wiring from the starter terminals.
- Remove the starter motor mounting bolts and remove the starter motor.

#### Installation

- Position the starter assembly to the flywheel housing and start the mounting bolts.
- Snug all the bolts while holding the starter squarely against its mounting surface and fully inserted into the pilot hole.
- 3. Tighten bolts to specification.
- 4. Connect the starter motor wiring.
- Lower the vehicle and connect the negative battery cable to the battery. Check operation of the starter motor.

## **DISASSEMBLY AND ASSEMBLY**

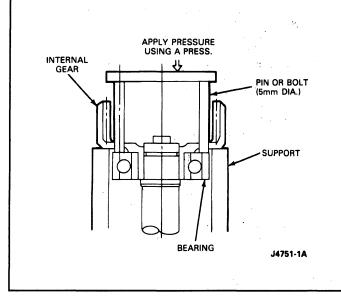


- Remove the screws securing the auxiliary switch and remove the switch.
- Loosen the M terminal on the solenoid and remove the connector. Remove the screws securing the main solenoid and remove the solenoid and adjusting shims.
- 3. Remove the through bolts securing the motor unit to the gear assembly and remove the motor.
- 4. Remove the armature from the motor housing.
- Remove the two screws from the brush holder and remove the end plate.
- Lift up on the brush springs and disconnect the brushes. Remove the brush holder.
- If required, remove the thrust washer from the end cover.
  - NOTE: The thrust washer is 0.25 or 0.5mm (.010 or .020 inch) thick.
- Remove the outer gear housing from the drive end housing and remove the adjusting shim.

- NOTE: This shim is 0.2 or 1.0mm (.008 or .039 inch) thick.
- Remove the seal, holder and spacer at the lever supporting point.
- Remove the two screws securing the inner gear housing in the drive end housing and remove the internal gear / shaft assembly with the drive and lever.
- 11. To remove the drive assembly (overrunning clutch), place a small pipe over the end of the shaft and tap the pipe with a hammer to loosen the retaining ring and expose the retaining clip. Remove the clip and remove the ring and overrunning clutch assembly. Remove the inner gear housing.
  - NOTE: If the retaining ring is difficult to remove, lightly file the burrs in the groove on the shaft to ease removal.
- Remove the armature bearings as required, using a suitable puller.

## **DISASSEMBLY AND ASSEMBLY (Continued)**

 Remove the bearing from the gear shaft by inserting two bolts through the two 6mm holes in the internal gear and pressing on the bolts to remove the bearing.



### **CLEANING AND INSPECTION**

#### **Armature Shaft and Commutator**

Using V-blocks and a dial indicator, check the armature shaft assembly for a bent shaft. If total shaft deflection indicated is more than 0.1mm (.004 inch), replace the armature.

With the same setup, move the dial indicator to rest on the commutator assembly. Maximum allowable total deflection is 0.1mm (.004 inch).

If the commutator surface is rough, it may be cleaned up using fine emery cloth or sand paper.

#### Gears

Replace components as required if gears are found to be worn or damaged.

#### **Bearings**

Replace bearings that do not turn smoothly, or if bearings produce abnormal sounds when turned.

#### **Pole Shoes**

Before assembling the starter motor, check the pole shoes for looseness. Tighten pole shoe retaining screws as required.

#### **Brush Holder and Brushes**

Clean old brush material from the brush holder before installation.

Replace brushes that are worn down, or have worn unevenly.

Check that brushes move smoothly in the brush holder.

#### **Overrunning Clutch**

Replace the overrunning clutch if the pinion gear is worn or damaged.

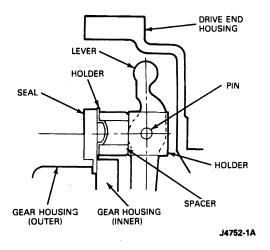
The pinion gear should rotate in one direction and hold in the other direction.

CAUTION: Do not clean the clutch in solvent. The clutch is a pre-greased sealed unit.

#### **Assembly**

NOTE: During assembly, lubricate all sliding parts, pivot points and gear teeth with Multemp MS No. 2 or equivalent lubricant.

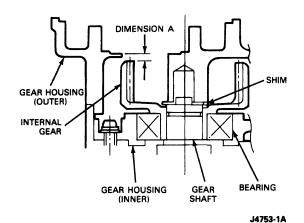
- Install the overrunning clutch on the gear shaft and slide the retaining ring on the shaft. Install the clip in the groove in the shaft and pull the retaining ring over the clip to snap it in position.
- Lubricate the lever pivot point with Multemp MS #2 or equivalent, and install the lever in the position shown. Apply a small amount of lubricant to the inside of the bushing in the drive end housing. Position the inner gear housing and shaft assembly in the drive end housing and install the two retaining screws.
- Install the holder and spacer at the lever supporting point. Do not install the seal at this time.



 Install the outer gear housing to the drive end housing, with the adjusting shim in place. Install the retaining screw.

## **CLEANING AND INSPECTION (Continued)**

 Check the shaft end play by moving the shaft up and down in the assembly and measuring "Dimension A" as shown. End play must be 0.025 - 0.5mm (.001 - .020 inch).



- Remove the screw for the outer gear housing and reinstall the housing with the required shim and the seal.
- Install the armature into the frame assembly and install a new rear seal on the frame assembly.
- Position the brush holder onto the armature and set the brush springs. Install this assembly to the outer gear housing with a new front seal.

 Install the end cover (with thrust washer) to the frame assembly and install the screws into the brush holder.

NOTE: The amount of armature thrust washer wear is generally minimal. If the armature, bearings, end plate or outer gear housing have not been replaced, the thrust washer probably does not need replacing. If components affecting the armature end play have been replaced, refer to the No-Load Test in Diagnosis and Testing in this section for procedure. If the no-load current draw is excessive, the thrust washer clearance may be too small.

- 10. Install the through-bolts.
- Install the solenoid and adjusting shims and secure with the screws.
- 12. Install the auxiliary switch with screws and install the connector to the M terminal.
- Check and adjust the drive gear gap as detailed in this section under Adjustments, Drive Pinion Gap.

#### SPECIAL SERVICE TOOLS

## ROTUNDA EQUIPMENT

| Model     | Description                  | •          |
|-----------|------------------------------|------------|
| 078-00005 | Starting and Charging Tester |            |
|           |                              | A 10400 4E |

## **SECTION 03-07 General Ignition Service**

| SUBJECT                          | SUBJECT PAGE                       |
|----------------------------------|------------------------------------|
| CLEANING AND INSPECTION          | REMOVAL AND INSTALLATION (Cont'd.) |
| Ignition Coil                    | Distributor Rotor03-07-4           |
| Spark Plug Wires03-07-13         | Ignition Module — TFI-IV           |
| Tachometer Connection            | Spark Plug Wires03-07-11           |
| DESCRIPTION                      | Spark Plugs03-07-11                |
| Ignition Systems Features03-07-1 | Stator Assembly03-07-5             |
| OPERATION03-07-1                 | SPECIAL SERVICE TOOLS              |
| REMOVAL AND INSTALLATION         | SPECIFICATIONS                     |
| Distributor Assembly             | VEHICLE APPLICATION03-07-1         |
| Distributor Cap03-07-3           |                                    |

## **VEHICLE APPLICATION**

**Light Truck** 

## **DESCRIPTION**

This Section is designed to serve as a guide in understanding, testing and servicing the TFI-IV Thick Film Integrated (TFI) ignition system.

## **Ignition Systems Features**

The TFI-IV ignition system features a camshaft driven distributor which uses no centrifugal or vacuum advance. The distributor has a diecast base which incorporates a Hall effect stator assembly.

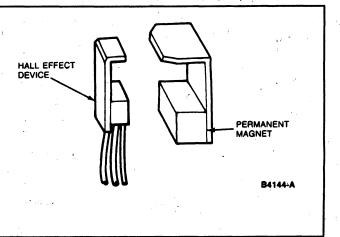
Initial timing adjustments are not required unless the distributor has been moved from its factory setting or removed from the engine. Ignition timing procedures and diagnostics are found in Section 13 of the Engine / Emissions Diagnosis\* manual.

NOTE: Do not change timing by use of different octane rods without first having the proper authorization; federal emission requirements will be affected.

There are two TFI-IV type systems: "Push Start" and Computer Controlled Dwell. The first TFI-IV System features a "push start" mode that will allow manual transmission vehicles to be push started. Do not attempt to push start automatic transmission vehicles. The second, Computer Controlled Dwell, features EEC-IV controlled ignition coil charge times.

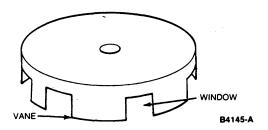
#### **OPERATION**

The universal distributor operates by using a Hall effect vane switch assembly, causing the ignition coil to be switched off and on by the EEC-IV and TFI-IV modules. The vane switch is an encapsulated package consisting of a Hall sensor on one side and a permanent magnet on the other side.

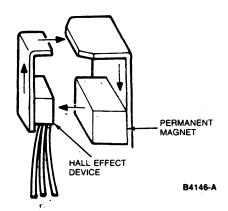


## **OPERATION (Continued)**

A rotary vane cup, made of ferrous metal, is used to trigger the signal off and on.

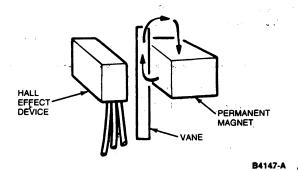


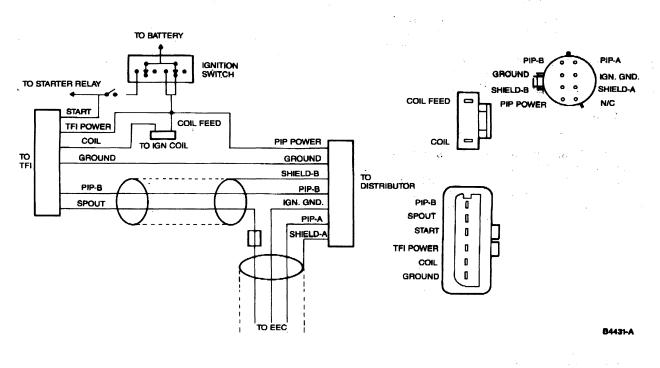
When the window of the vane cup is between the magnet and the Hall effect device, a magnetic flux field is completed from the magnet through the Hall effect device and back to the magnet.



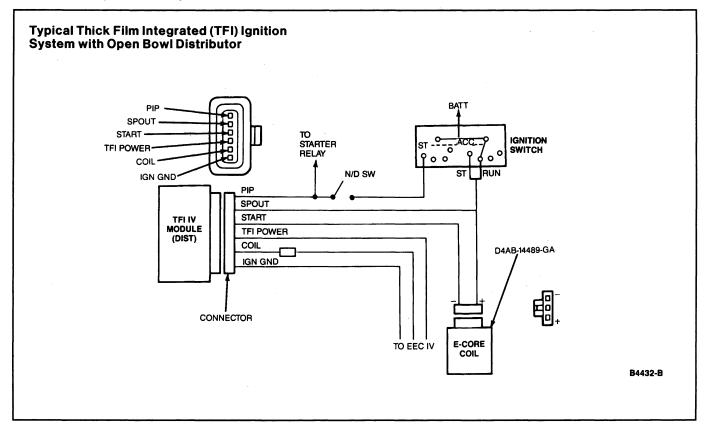
Typical Thick Film Integrated (TFI) Ignition System and Closed Bowl Distributor As the vane passes through this opening, the flux lines are shunted through the vane and back to the magnet.

During this time, a voltage is produced as the vane passes through the opening. When the vane clears the opening, the window edge causes the signal to go to zero volts. The signal is then used by the EEC-IV system for crankshaft position sensing and the computation of the desired spark advance based on engine demand and calibration. The conditioned spark advance and voltage distribution is accomplished through a conventional rotor, cap and ignition wires.





## **OPERATION (Continued)**



#### REMOVAL AND INSTALLATION

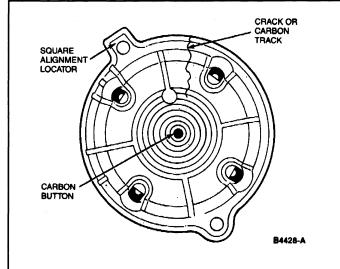
#### **Distributor Cap**

#### Removal

Loosen distributor cap hold-down screws. Remove cap straight off distributor to prevent damage to rotor blade and spring.

#### Cleaning and Inspection

Wash both inside and outside surfaces of the distributor cap with soap and water. Dry cap with compressed air. Inspect cap for cracks, broken carbon button or carbon tracks. Also, inspect cap terminals for dirt and corrosion. Replace the cap if it is damaged.



## Installation

- Position distributor cap on distributor base noting the square alignment locator. Tighten hold-down screws to 2.0-2.6 N·m (18-23 lb-in).
- Reinstall any ignition wires that were removed, noting their correct locations on the distributor cap.

#### **Distributor Rotor**

#### Removal

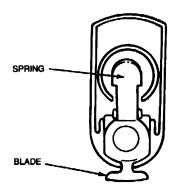
With distributor cap removed, pull rotor upward to remove it from distributor shaft and armature.

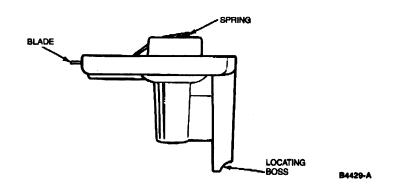
#### **Cleaning and Inspection**

Wash rotor with soap and water. Dry with compressed air. Inspect and replace rotor if cracks, carbon tracks, burns or damage to blade or spring are observed.

#### Installation

Align locating boss on rotor with hole on armature. Fully seat rotor on distributor shaft. Reinstall distributor cap.





## **Distributor Assembly**

#### Removal

- 1. Disconnect distributor from wiring harness.
- Mark position of No. 1 cylinder wire tower on distributor base for reference when installing distributor.
- Loosen distributor cap hold-down screws.
   Remove cap straight off distributor to prevent damage to rotor blade and spring. Position cap and attached wires aside so as not to interfere with distributor removal.
- 4. Remove rotor by pulling upward to remove it from the distributor shaft and armature.
- 5. Remove distributor hold-down bolt and clamp. Remove distributor by pulling upward.
- Cover distributor opening in the cylinder block or head with a clean shop towel to prevent the entry of foreign material or dirt into the engine.

#### Installation

Before installing distributor, visually inspect distributor. Inspect O-ring. It should fit tightly and be free of cuts. The drive gear should be free of nicks, cracks and excessive wear. Rotate distributor drive shaft. It should move freely, without binding.

 To install distributor correctly, No. 1 piston must be at Top Dead Center (TDC) of compression stroke. Remove No. 1 cylinder spark plug and rotate engine clockwise until No. 1 piston is on the compression stroke.

- With No. 1 piston on compression stroke, align timing pointer with TDC on the crankshaft damper.
- Align locating boss on rotor with hole on armature. Fully seat rotor on distributor shaft.
- Rotate distributor shaft so blade on rotor is pointing toward mark on distributor base, that was previously made in Step 2 of the Removal procedure.
- While installing distributor, continue rotating rotor slightly so leading edge of the vane is centered in vane switch stator assembly.
- Rotate distributor in block to align leading edge of vane and vane switch stator assembly. Verify rotor is pointing at No. 1 mark on distributor base.

If vane and vane switch stator cannot be aligned by rotating distributor in cylinder block, remove distributor enough to just disengage distributor gear from camshaft gear. Rotate rotor enough to engage distributor gear on another tooth of camshaft gear. Repeat Step 1 if necessary.

- Install distributor hold-down clamp and bolt.
   Tighten bolt, but leave it loose enough to rotate distributor.
- Install distributor cap, No. 1 spark plug and ignition wires. Check that ignition wires are securely connected to the cap and spark plugs. Tighten distributor cap hold-down screws to 2.0-2.6 N·m (18-23 lb-in).
- Reconnect distributor to wiring harness.

- Set initial timing according to procedures found in Section 13 of the Engine / Emissions Diagnosis\* manual.
- After timing is set, tighten distributor hold-down bolt. Refer to Specifications.
- 12. Recheck initial timing. Adjust if necessary.

#### **Stator Assembly**

#### **Except 4.9L Engine**

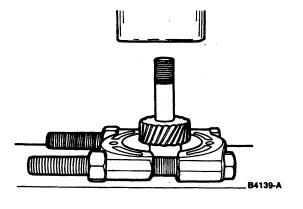
#### Removal

NOTE: Do not attempt to replace stator without an arbor press.

- Using a screwdriver, remove distributor cap, position the cap and wires aside so as not to interfere with work area. Disconnect distributor from harness.
- 2. Remove distributor from block as outlined.
- 3. Remove rotor.
- Remove two screws holding TFI-IV module to the base, if so equipped.
- Remove module, wipe grease from base and module, keeping surfaces free of dirt, if so equipped.
- 6. Remove two screws holding armature and , remove armature.

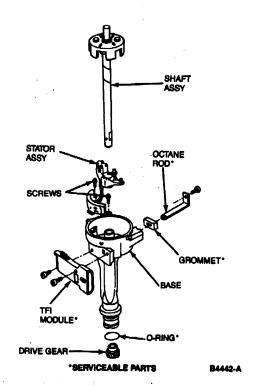
NOTE: Hold gear to loosen armature screws, do not hold armature.

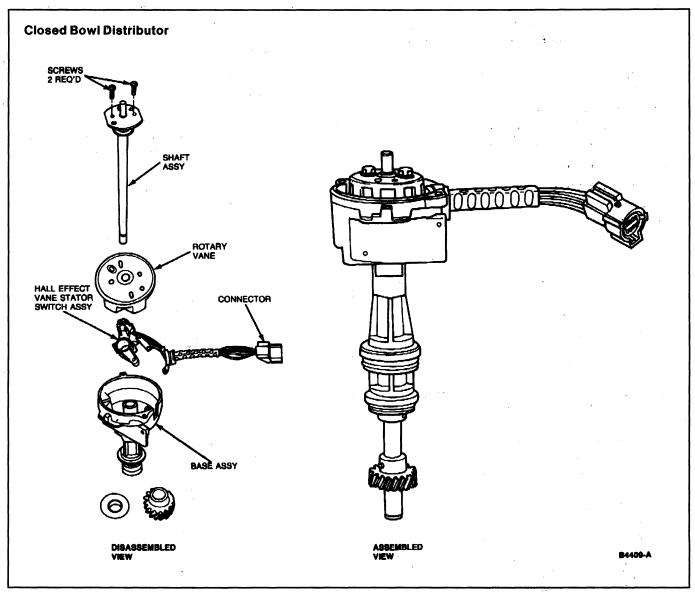
- 7. To ease assembly, mark armature and gear with a felt tip pen, to note orientation.
- 8. Remove and discard pin in gear.
- Invert distributor and place in Axle Bearing / Seal Plate T75L-1165-B or equivalent, and press off gear using the Bearing Removal Tool D84L-950-A or equivalent.



- Deburr and polish shaft with emery paper and wipe such that shaft slides out freely from distributor base.
- 11. Remove shaft assembly.
- 12. Remove two stator assembly screws and retain.
- 13. Remove stator assembly from top of bowl.
- Inspect base bushing for wear or signs of excess heat concentration. Replace complete distributor assembly if damaged.
- 15. Inspect base O-ring for cuts or damage and replace O-ring if necessary.
- Inspect base for cracks and wear. Replace complete distributor assembly if damage is found.

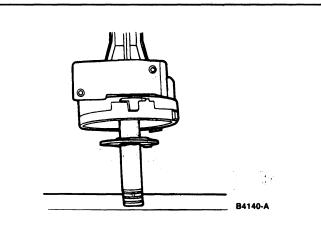
#### **Open Bowl Distributor**





## **Assembly and Installation**

- Place stator assembly over bushing and press down to seat.
- Place stator connector in position. Tab should fit in notch on base and fastening eyelets aligned with screw holes.
- Position wires away from moving parts.
- 4. Install two stator screws and tighten to 1.7-4.0 N·m (15-35 lb-in).
- 5. Apply a light coat of Motor Oil ESF-M2C70-A or equivalent, to distributor shaft below armature.
- 6. Insert shaft through base bushing.
- 7. Place a 1/2-inch deep well socket over shaft, invert and place on arbor plate.

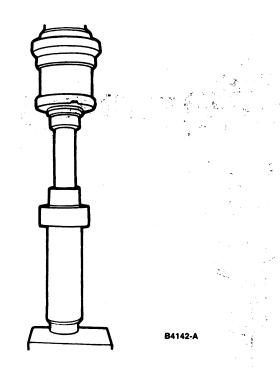


Place the distributor gear on shaft end. Line up the mark on armature and gear.

NOTE: The hole in the shaft and gear must be lined up as accurately as possible to ensure ease of roll pin insertion.

 Place a 5/8 inch deep well socket over the shaft and gear and press gear to align with original drill hole

NOTE: If the gear holes do not align, the gear must be removed and repressed on. A drift punch will not align the holes.



- 10. Insert new roll pin through gear and shaft. Pin should have proper extrusion.
- 11. Replace armature and tighten screws to 2.8-4.0 N·m (25-35 lb-in).
- Check distributor for free movement over full rotation of shaft.

NOTE: If the armature contacts the stator, replace the entire distributor.

- 13. Wipe back of TFI-IV module and distributor module mounting face free of all dirt, if so equipped.
- Apply Silicone Dielectric Compound D7AZ-19A331-A or equivalent to the back of the TFI-IV module and spread thinly and evenly, if so equipped.
- 15. Turn distributor base upside down so that the stator connector is in full view.
- Insert module and watch that the three module pins are inserted into the stator connector. Fully seat the module into the connector and against base.
- Install two module screws and tighten to 1.7-4.0
   N·m (15-35 lb-in), if so equipped.

- Install the distributor into block per distributor replacement procedure.
- 19. Connect distributor module to wiring harness.
- 20. Replace rotor.
- 21. Replace cap and tighten screws to specification.
- 22. Set engine timing.

## 4.9L Engine

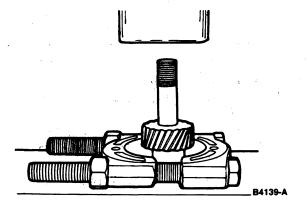
#### Removal

NOTE: Do not attempt to replace stator without an arbor press.

- Using a screwdriver, remove distributor cap, position the cap and wires aside so as not to interfere with work area. Disconnect distributor from harness.
- 2. Remove distributor from block as outlined.
- 3. Remove rotor.
- 4. Remove two screws holding TFI-IV module to the base, if so equipped.
- Remove module, wipe grease from base and module, keeping surfaces free of dirt, if so equipped.
- 6. Remove two screws holding armature and remove armature.

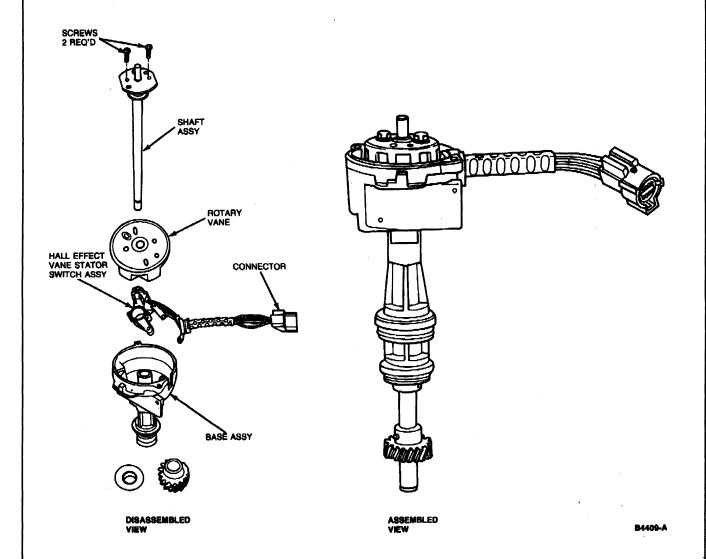
NOTE: Hold gear to loosen armature screws, do not hold armature.

- 7. To ease assembly, mark armature and gear with a felt tip pen, to note orientation.
- 8. Remove and discard pin in gear.
- Invert distributor and place in Axle Bearing / Seal Plate T75L-1165-B or equivalent, and press off gear using the Bearing Removal Tool D84L-950-A or equivalent.
- Remove the thrust washer from the distributor and set it aside for assembly.



- Deburr and polish shaft with emery paper and wipe such that shaft slides out freely from distributor base.
- 12. Remove shaft assembly.

- 13. Remove two stator assembly screws and retain.
- 14. Remove stator assembly from top of bowl.
- Inspect base bushing for wear or signs of excess heat concentration. Replace complete distributor assembly if damaged.
- 16. Inspect base O-ring for cuts or damage and replace O-ring if necessary.
- 17. Inspect base for cracks and wear. Replace complete distributor assembly if damage is found.

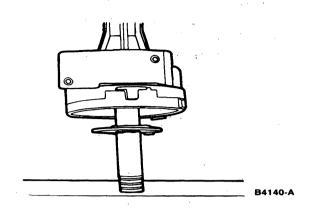


#### **Assembly and Installation**

- Place stator asssembly overbushing and press down to seat.
- Place stator connector in position. Tab should fit in notch on base and fastening eyelets aligned with screw holes.
- 3. Position wires away from moving parts.

- 4. Install two stator screws and tighten to 1.7-4.0 N-m (15-35 lb-in).
- Apply a light coat of Motor Oil ESF-M2C70-A or equivalent to distributor shaft below armature.
- 6. Insert shaft through base bushing.
- 7. Place a 1/2 inch deep well socket over shaft, invert and place on arbor plate.

8. Install gear thrust washer.

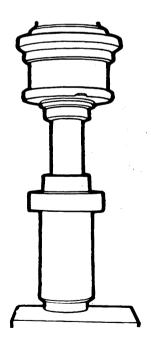


Place the distributor gear on shaft end. Line up the mark on armature and gear.

NOTE: The hole in the shaft and gear must be lined up as accurately as possible to ensure ease of roll pin insertion.

 Place a 5/8 inch deep well socket over the shaft and gear and press gear to align with original drill hole.

NOTE: If the gear holes do not align, the gear must be removed and repressed on. A drift punch willnot align the holes.



B4142-A

- 11. Insert new roll pin through gear and shaft. Pin should have proper extrusion.
- 12. Replace armature and tighten screws to 2.8-4.0 N·m (25-35 lb-in).
- Check distributor for free movement over full rotation of shaft.

- NOTE: If the armature contacts the stator, replace the entire distributor.
- Wipe back of TFI-IV module and distributor module mounting face free of all dirt, if so equipped.
- Apply Silicone Dielectric Compound D7AZ-19A331-A or equivalent to the back of the TFI module and spread thinly and evenly, if so equipped.
- Turn distributor base upside down so that the stator connector is in full view.
- Insert module and watch that the three module pins are inserted into the stator connector. Fully seat the module into the connector against base.
- 18. Install two module screws and tighten to 1.7-4.0 N·m (15-35 lb-in), if so equipped.
- 19. Install the distributor into block per distributor replacement procedure.
- 20. Connect distributor module to wiring harness.
- 21. Replace rotor.
- 22. Replace cap and tighten screws to specification.
- 23. Set engine timing.

## Ignition Module—TFI-IV All Except 7.5L Engine

#### Removal

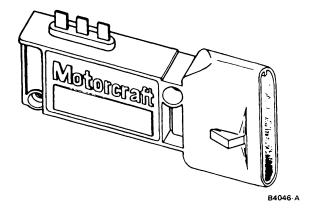
- Using a screwdriver, remove distributor cap and position it and attached wires aside so as not to interfere with work area.
- 2. Remove TFI-IV harness connector.
- 3. Remove distributor from engine.
- Place distributor on work bench. Remove two TFI-IV module attachment screws.
- Pull RH side of module down distributor mounting flange and back up to disengage module terminals from connector in distributor base. The module may be pulled toward flange and away from distributor.

CAUTION: Do not attempt to lift module from mounting surface prior to moving entire TFI-IV module toward distributor flange as pins will break at distributor/module connector.

#### Installation

- Coat metal base plate of TFI-IV ignition module uniformly with silicone compound, approximately 0.79mm (1/32-inch) thick. Use Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
- Place TFI-IV module on distributor base mounting flange.

- Carefully position TFI-IV module assembly toward distributor bowl and engage three distributor connector pins securely.
- Install two TFI-IV module mounting screws and tighten to 1.7-4.0 N-m (15-35 lb-in) starting with upper RH screw.
- 5. Install distributor on engine.
- Install distributor cap. Tighten cap mounting screws to 2.0-2.6 N·m (18-23 lb-in).
- 7. Install TFI-IV harness connector.
- Using an induction timing lamp, verify engine timing. Refer to Vehicle Emission Control Information decal.



## 7.5L Engine

#### Removal

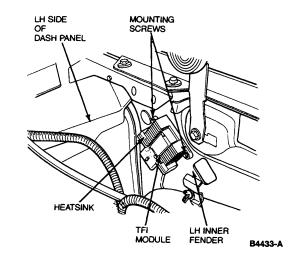
- Remove two screws retaining TFI/heatsink assembly to LH fender apron.
- 2. Disconnect harness connector from TFI module.
- Remove two screws retaining TFI module to heatsink and remove TFI module.

#### Installation

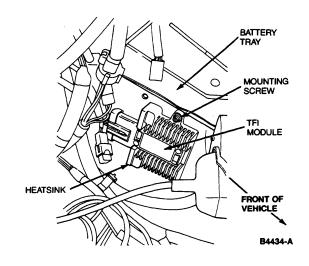
 Coat metal baseplate of the TFI ignition module uniformly with silicone compound, approximately 0179mm (1/32-inch) thick. Use Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent.

- Position module onto heatsink and tighten two retaining screws to 1.7-4.0 N·m (15-35 lb-in).
- Install TFI module / heatsink assembly to LH fender apron using two retaining screws.
- Connect wire harness to the TFI module.

#### F-250, F-350, Super Duty



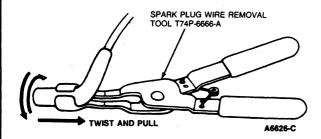
E-250, E-350



## **Spark Plug Wires**

#### Removal

 When removing wires from spark plugs, use Spark Plug Wire Removal Tool T74P-6666-A or equivalent. Grasp and twist the boot back and forth on plug insulator to free boot. Use special tool to pull boot from plug. Do not pull on wire directly, or it may become separated from connector inside boot.



When removing wires from distributor cap or coil, grasp boot by hand and remove with twisting and pulling motion. Do not pull on wire.

#### Installation

- Whenever a high tension wire is removed for any reason from a spark plug, coil or distributor cap, or a new high tension wire is installed, Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C171-A) or equivalent must be applied to boot before it is reconnected. Using a small clean tool, coat entire interior surface of boot with Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
- Insert each wire on proper terminal of distributor cap. Ensure wires are all the way down over their terminals. The No. 1 terminal is identified on cap. Install wires starting with No. 1 terminal.
- Remove wire retaining brackets from old high tension wire set and install them on new set in same relative position. Install wires in brackets on valve rocker arm covers.
- 4. Connect wires to proper spark plugs.
- 5. Install coil wire.

#### **Spark Plugs**

#### Removal and Installation

Refer to the appropriate engine section for spark plug removal and installation.

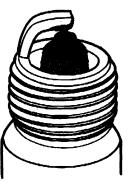
Refer to the Spark Plug Inspection Chart to determine the condition of the spark plugs.

#### **Spark Plug Inspection Chart**

#### GAP BRIDGED

IDENTIFIED BY DEPOSIT BUILD— UP CLOSING GAP BETWEEN ELECTRODES.

CAUSED BY OIL OR CARBON FOULING, REPLACE PLUG, OR, IF DEPOSITS ARE NOT EXCESSIVE THE PLUG CAN BE CLEANED.

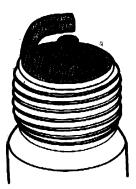


#### OIL FOULED

IDENTIFIED BY WET BLACK DEPOSITS ON THE INSULATOR SHELL BORE ELECTRODES.

CAUSED BY EXCESSIVE OIL ENTERING COMBUSTION CHAMBER THROUGH WORN RINGS AND PISTONS, EXCESSIVE CLEARANCE BETWEEN VALVE GUIDES AND STEMS, OR WORN OR LOOSE BEARINGS. CORRECT OIL PROBLEM. REPLACE THE PLUG.

#### CARBON FOULED



IDENTIFIED BY BLACK, DRY FLUFFY CARBON DEPOSITS ON INSULATOR TIPS, EXPOSED SHELL SURFACES AND ELECTRODES.

CAUSED BY TOO COLD A PLUG, WEAK IGNITION, DIRTY AIR CLEANER, DEFECTIVE FUEL PUMP, TOO RICH A FUEL MIXTURE, IMPROPERLY OPERATING HEAT RISER OR EXCESSIVE IDLING. CAN BE CLEANED.

#### NORMAL



IDENTIFIED BY LIGHT TAN OR GRAY DEPOSITS ON THE FIRING TIP.

#### PRE-IGNITION



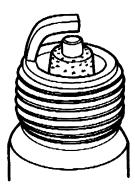
IDENTIFIED BY MELTED ELECTRODES AND POSSIBLY BLISTERED INSULATOR. METALIC DEPOSITS ON INSULATOR INDICATE ENGINE DAMAGE.

CAUSED BY WRONG TYPE OF FUEL, INCORRECT IGNITION TIMING OR ADVANCE, TOO HOT A PLUG, BURNT VALVES OR ENGINE OVERHEATING. REPLACE THE PLUG.

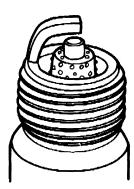
#### OVERHEATING

IDENTIFIED BY A WHITE OR LIGHT GRAY INSULATOR WITH SMALL BLACK OR GRAY BROWN SPOTS AND WITH BLUISH-BURNT APPEARANCE OF ELECTRODES.

CAUSED BY ENGINE OVER-HEATING, WRONG TYPE OF FUEL, LOOSE SPARK PLUGS, TOO HOT A PLUG, LOW FUEL PUMP PRESSURE OR INCORRECT IGNITION TIMING. REPLACE THE PLUG.



## FUSED SPOT DEPOSIT



IDENTIFIED BY MELTED OR SPOTTY DEPOSITS RESEMBLING BUSBLES OR BLISTERS.

CAUSED BY SUDDEN ACCELERATION. CAN BE CLEANED IF NOT EXCESSIVE, OTHERWISE REPLACE PLUG.

B4054-E

# Spark Plug Hole Taperset Installation CAUTION: Use protective eye glasses at all times.

NOTE: Cylinder head must be removed from vehicle to prevent metal shavings from entering engine.

Refer to appropriate engine Section for cylinder head removal and installation.

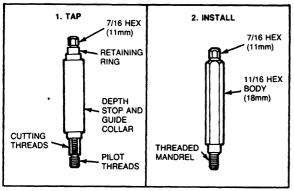
#### Tap

- Thoroughly clean spark plug counter bore walls and seat of all dirt and foreign material.
- 2. Lubricate cutting threads of tap with cutting oil.
- 3. Engage tap pilot into spark plug port threads.
- Using ratchet wrench and keeping tap aligned, rotate tap until depth stop collar bottoms on face of port and tightens against retaining ring.
   NOTE: Use of power tools is not approved for installation of tapersets.
- Using an air hose, blow out as many shavings as possible.
- If stop collar is loose, tap has not penetrated to full depth.
- 7. Remove tap from hole.
- Clear shavings from hole and cylinder with air hose.

#### Installation

## CAUTION: Repeat Steps 1 through 8 to ensure a clean bore.

 Lubricate mandrel threads and taperset with aluminum cutting coil. Then thread taperset onto mandrel with larger counterbore end toward 18mm (11/16-inch) hex body until one thread of mandrel shows beyond tip of taperset.



B4031-B

- 2. Install taperset into tapped hole. Tighten 18mm (11/16-inch) hex to 68 N·m (50 lb-ft).
- Holding 11mm (7 / 16-inch) hex mandrel to prevent rotation, loosen 18mm (11 / 16-inch) hex body approximately one-half turn to achieve breakaway action.

- Remove tool from installed taperset.
   NOTE: Taperset should be flush to 1mm (0.039 inch) below spark plug gasket seat.
- 5. Thoroughly clean cylinder head before installing spark plug. Tighten spark plugs to 9-20 N·m (7-15 lb-ft).

#### **CLEANING AND INSPECTION**

#### **Ignition Coil**

Wipe coil tower with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect for cracks, carbon tracking and dirt.

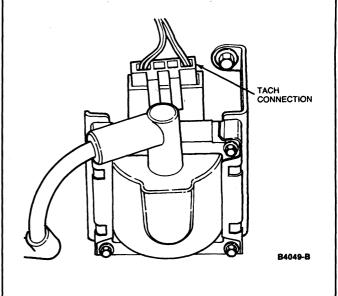
#### **Spark Plug Wires**

Without removing the high tension wires from the spark plugs, distributor cap or coil, wipe the wires with a clean, damp cloth and inspect them for visible damage such as cuts, pinches, cracks or torn boots. Replace only wires that are damaged. Refer to Spark Plug Wire, Removal and Installation.

#### **Tachometer Connection**

The ignition coil connector allows a tachometer connection using an alligator clip, without removing the coil connector. This is accomplished by inserting the alligator clip into the back of the connector, onto the dark green/yellow dotted wire.

CAUTION: Do not allow this clip to accidently ground to a metal surface. It may permanently damage the coil.



## **SPECIFICATIONS**

#### TORQUE SPECIFICATIONS Description N⋅m Lb-in Distributor Holddown Bolts 23-34 17-25 (Lb-Ft) Stator Assembly Screws 1.7-4.0 15-35 Spark Plugs 9-20 7-15 (Lb-Ft) **TFI Ignition Module** 1.7-4.0 15-35 Distributor Cap Holddown Screws ---2.0-2.6 18-23 4.9L Octane Rod Retaining Screw 1.7-4.0 15-35 Distributor Adapter to Distributor Base 2.8-4.0 25-35

## **SPECIAL SERVICE TOOLS**

| Tool Number     | Description               |     | × . *                        |    |
|-----------------|---------------------------|-----|------------------------------|----|
| T75L-1165-B 🦠 🔻 | Axle Bearing/Seal Plate   |     |                              |    |
| D84L-950-A      | Bearing Removal Tool      |     | L-950-A Bearing Removal Tool | 43 |
| T74P-6666-A     | Spark Plug Wire Removal T | ool |                              |    |
|                 | <u> </u>                  |     |                              |    |
|                 |                           |     |                              |    |
|                 |                           |     |                              |    |
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## **SECTION 03-12 Air Cleaners**

| SUBJECT                                 | PAGE    | SUBJECT  | PAGE    |
|---|---------|--|---------|
| DESCRIPTION Air Cleaner — Diesel Engine | 03-12-1 | REMOVAL AND INSTALLATION Air Cleaner — Diesel Engine | 03-12-8 |
| Air Cleaner — Gasoline Engines          |         | Air Cleaner — Gasoline Engines                       | 03-12-  |
|   | •       | VEHICLE APPLICATION                                  | 03-12-1 |

#### **VEHICLE APPLICATION**

Light Truck Vehicles Equipped with Gasoline and Diesel Engines

#### DESCRIPTION

#### Air Cleaner—Gasoline Engines

Dry-type air cleaners are standard on F-150 through F-350 and F-Super Duty series, Bronco and E-150—E-350 series vehicles.

Air enters the air cleaner and travels through a chemically treated and pleated paper element before entering the engine induction system. The air filter element should be inspected, cleaned, or replaced periodically according to the schedule in Section 00-03, Maintenance. The air cleaner system has a heat sensor mounted in the cleaner assembly to control engine inlet air temperature (on some models).

#### Air Cleaner—Diesel Engine

A dry-type air cleaner is standard equipment on all Ford trucks equipped with diesel engines. Air is filtered through a pleated, chemically treated paper element to remove contaminants before entering the engine induction system.

#### **REMOVAL AND INSTALLATION**

#### Air Cleaner—Gasoline Engines

Refer to the illustrations in this Section for removal and installation of the various types of air cleaners. Reference to the illustrations will enable the service technician to perform the required removal and installation and/or repair operations. For all engines, refer to the following procedure.

#### Removal

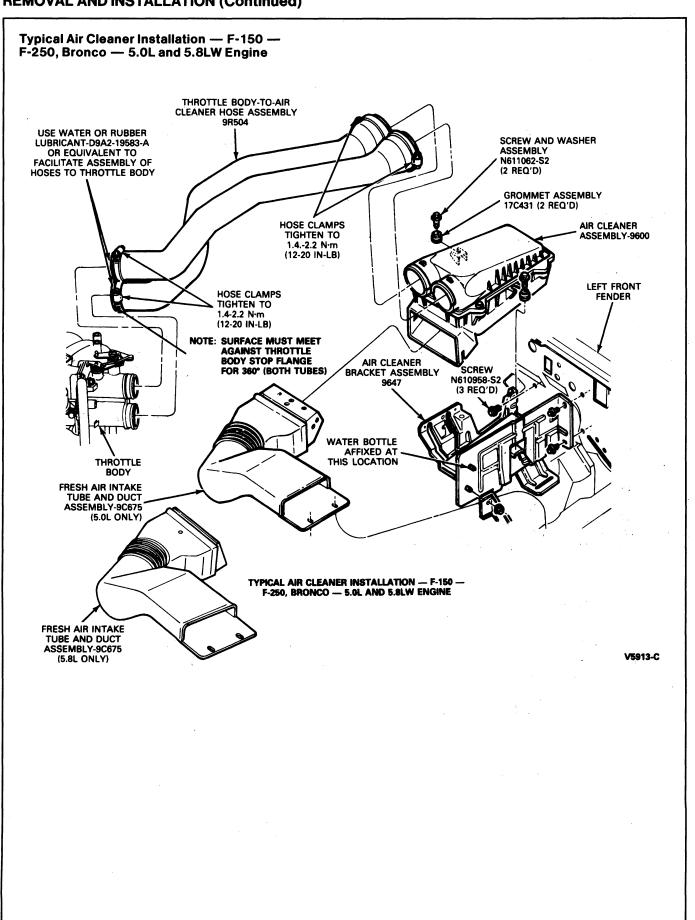
- Loosen two hose clamps securing hose assembly to air cleaner.
- Remove two screws attaching air cleaner to bracket.
- Disconnect hose and inlet tube from air closure hose / filter pack. (On E-Series, disconnect hose and inlet tube from thermactor air pump inlet.)

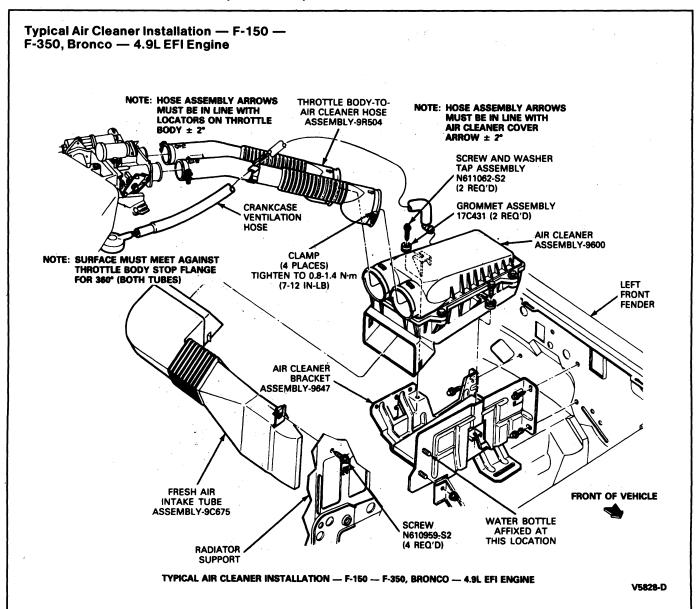
- 4. Remove screws attaching air cleaner cover.
- 5. Remove air filter and tubes.

## Installation

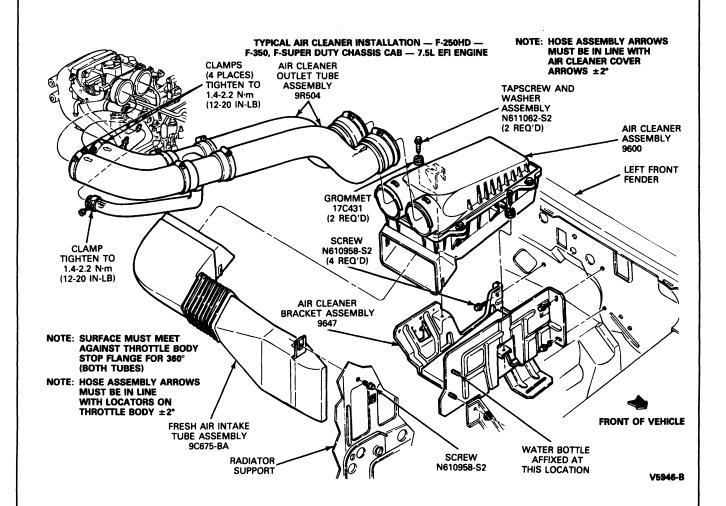
- Set air filter into proper position.
- Position air cleaner cover to tray. Ensure filter is seated while positioning cover.
- 3. Install screws to secure cover.
- Install two bolts to secure air cleaner to support bracket.
- Install fresh air inlet tube to air closure hose / filter pack. (On E-Series, connect hose and inlet tube to thermactor air pump inlet.)
- Install air supply tube to air cleaner and retain with clamps. Tighten clamps to specifications.

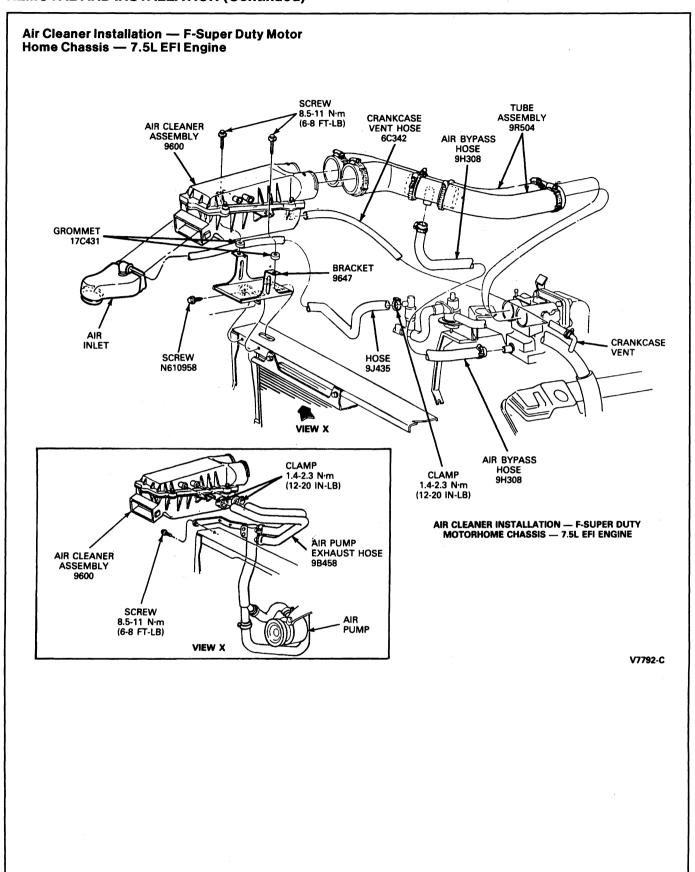
03-12-1

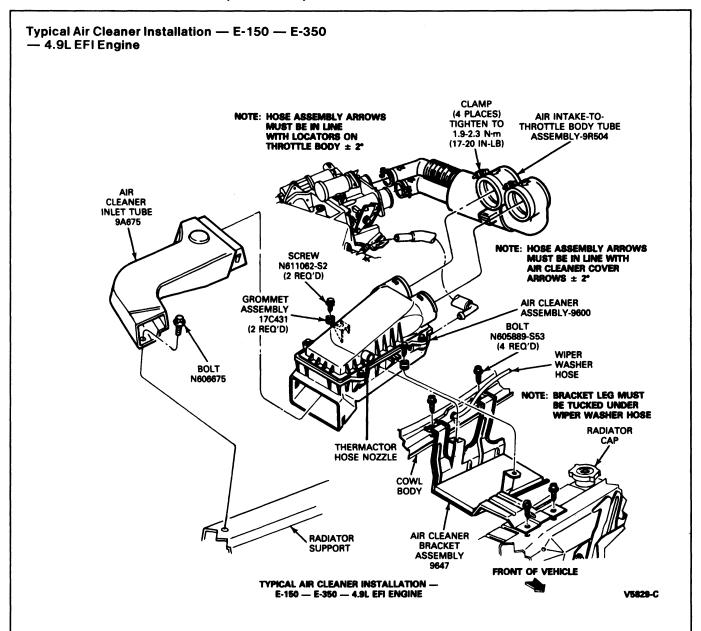


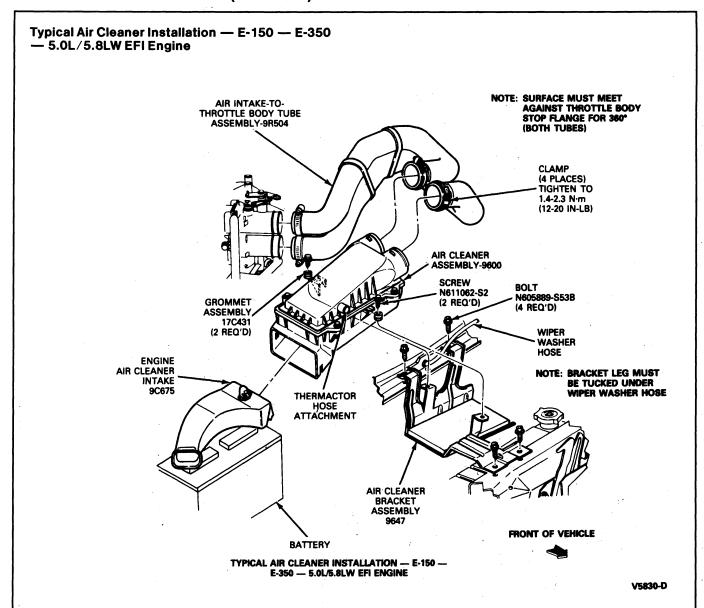


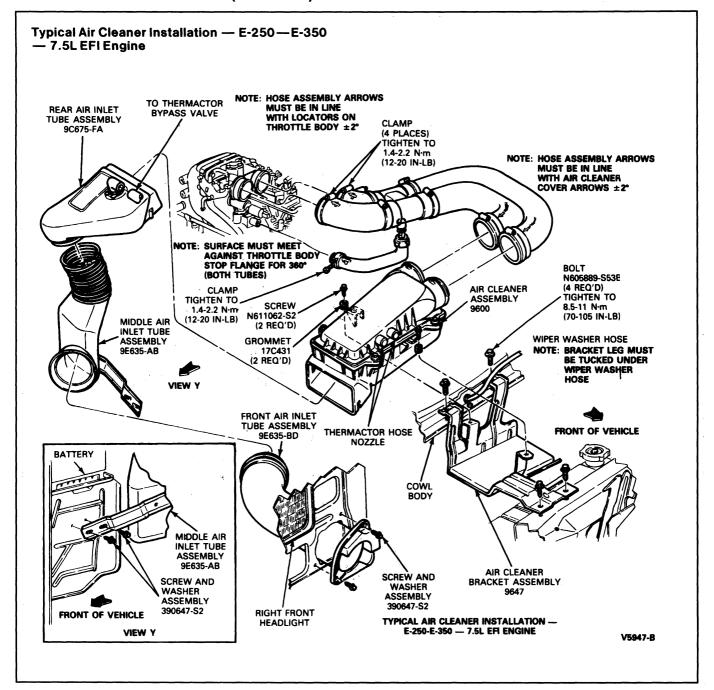
Typical Air Cleaner Installation — F-250HD — F-350, F-Super Duty Chassis Cab — 7.5L EFI Engine











## Air Cleaner—Diesel Engine Removal

- Loosen wing bolt. Then, remove air cleaner assembly as a unit before disassembly.
  - Before installing a new element in the air cleaner, check the following items:
  - Gasket surfaces should be clean and undamaged.
  - b. Inlet tube should be clean and undamaged.

- Element should be dry and free of holes, ruptures, damaged gaskets or dents in end covers and liners.
- Element retaining nut or bolt should have the gasket washer attached and it should be in good condition.
- Inspect water drain hose (F-Series only) for possible restrictions caused by contaminants. Replace hose (9F765) if cracked or damaged.

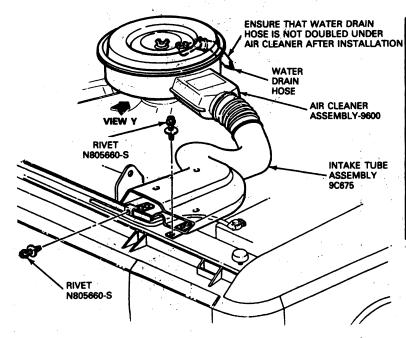
#### Installation

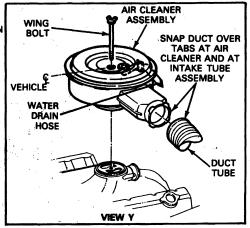
After the air cleaner, element, and other parts are found to be in good condition, reassemble the parts.

- Install the element. Ensure the rubber face of the washer seals against the element.
  - CAUTION: A special water resistant element is required. Use only a specific Ford replacement. Use of other elements could result in serious engine damage.
- 2. Install the cover. Ensure gasket, if supplied, is in place. Replace a worn or damaged gasket.

- Install air cleaner assembly and tighten wing bolt securely.
- On F-Series only, ensure that the rubber water drain hose is not doubled under, kinked or bent and is positioned freely.

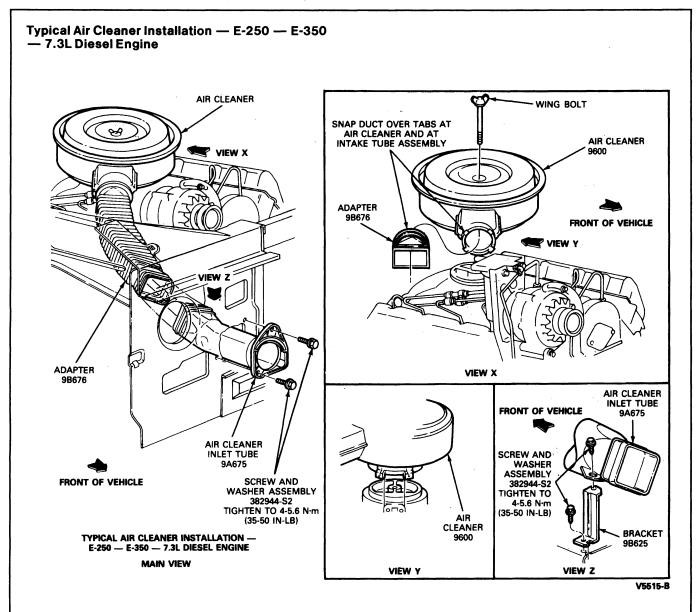
Typical Air Cleaner Installation — F-250 HD, F-350, F-Super Duty Chassis Cab — 7.3L Diesel Engine





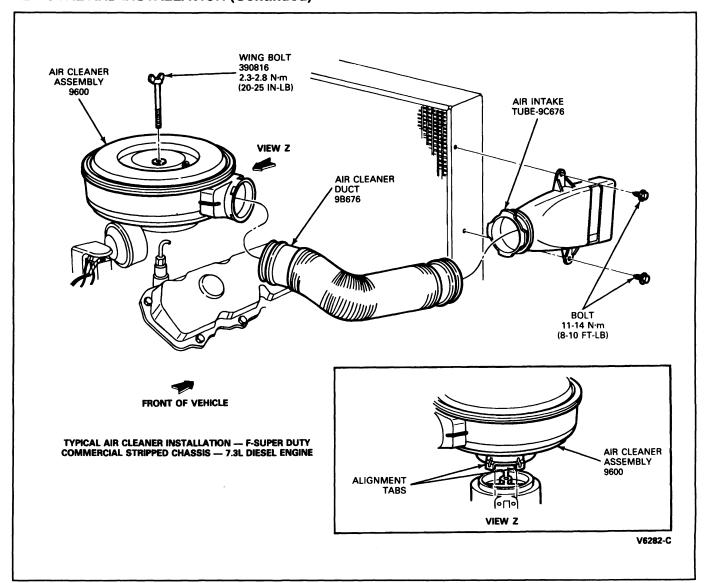
TYPICAL AIR CLEANER INSTALLATION — F-250HD, F-350, F-SUPER DUTY CHASSIS CAB

V3566-E



# Typical Air Cleaner Installation — F-Super Duty Commercial Stripped Chassis — 7.3L Diesel Engine

Refer to the following illustration for air cleaner installation on F-Super Duty Commercial Stripped Chassis vehicles equipped with 7.3L Diesel Engines.



## **GROUP**

# **EXHAUST SYSTEMS**



## **SECTION 09-00 Exhaust System**

| SUBJECT PAGE                            | SUBJECT                          | PAGE     |
|---|----------------------------------|----------|
| ADJUSTMENTS                             | REMOVAL AND INSTALLATION         |          |
| Exhaust System Alignment09-00-4         | Hanger Brackets                  | 09-00-5  |
| DESCRIPTION09-00-1                      | Muffler and Outlet Pipe Assembly | 09-00-5  |
| DIAGNOSIS AND TESTING                   | Muffler Shields                  |          |
| Diagnosis Guides09-00-2                 | SPECIAL SERVICE TOOLS            | 09-00-24 |
| Restricted Exhaust System Test-Gasoline | SPECIFICATIONS                   |          |
| Engines09-00-2                          | VEHICLE APPLICATION              | 09-00-1  |

#### **VEHICLE APPLICATION**

E-150—E-350, F-150—F-350, F-Super Duty, Bronco, Commercial Stripped Chassis and Motor Home Chassis Vehicles

#### DESCRIPTION

Exhaust systems vary between engine, transmission and vehicle models. Catalytic converters use clamshell catalysts of monolithic construction. The catalytic agent is an alloy of platinum, palladium and rhodium. All gasoline-powered vehicles employ the catalytic converter in their emission control systems. All gasoline powered vehicles run on unleaded fuel.

The diesel engine does not use a catalytic converter, and uses only diesel fuel.

Illustrations given in this section show typical exhaust systems.

The location and type of exhaust system gaskets, retaining clamps and support brackets are shown in the exhaust system illustrations.

This section covers general exhaust system alignment procedures and specifications.

#### DIAGNOSIS AND TESTING

Exhaust system performance complaints such as excessive back-pressure is usually noticeable by its effect on engine performance.

However, other malfunctioning components may have similar effects on engine performance and be characterized by the same symptoms or complaints. It is, therefore, necessary to refer to the engine diagnosis and service procedures in Engine / Emission Diagnosis Manual,\* when attempting to diagnose this type of problem.

## **DIAGNOSIS AND TESTING (Continued)**

For general exhaust system complaints refer to the diagnosis guide listed in this section.

## Restricted Exhaust System Test-Gasoline Engines

With the engine at normal operating temperature, connect a Rotunda Vacuum Gauge 059-00008 or equivalent to the intake manifold. A gradual drop in the vacuum gauge reading at idle will indicate a restricted exhaust system.

Refer to the Engine / Emission Diagnosis Manual\* for test procedures for the 7.3L Diesel engine.

## **Diagnosis Guides**

#### NOISY OR LEAKING EXHAUST DIAGNOSIS GUIDE

|    | TEST STEP   | RESULT      | ACTION TO TAKE   |
|----|---|-------------|--|
| A0 | CLAMPS AND BRACKETS   |             |  |
|    | Check for broken or loose clamps and/or brackets.   | <b>⊗</b> ►  | GO to A1.  |
|    |   | <b>∅</b> ►  | REPAIR or REPLACE as necessary. Restart engine. If noise still exists GO to A1.                                  |
| A1 | SYSTEM COMPONENTS   |             |  |
|    | <ul> <li>Check inlet pipe and muffler for punctures, split<br/>seams, or improper welds.</li> </ul> | ØK ▶        | GO to <b>A2</b> .  |
|    |   | <b>⊗</b> ▶  | REPLACE inlet pipe and/<br>or muffler as necessary.<br>If noise still exists GO to<br>A2.                        |
| A2 | EXHAUST MANIFOLD  |             |  |
|    | Inspect exhaust manifold for loose fasteners or cracks.   | Øk <b>▶</b> | GO to <b>B0</b> .  |
|    |   | <b>Ø</b> ►  | TIGHTEN fasteners to specification or REPLACE exhaust manifold. REFER to specific engine section in this manual. |

CU1824-2C

<sup>\*</sup>Can be purchased as a separate item.

<sup>\*</sup>Can be purchased as a separate item.

## **DIAGNOSIS AND TESTING (Continued)**

|            | TEST STEP  | RESULT     |              | ACTION TO TAKE                               |
|------------|--|------------|--------------|--|
| <b>B</b> 0 | VISUAL INSPECTION  |            |              |  |
|            |  |            | _            |  |
|            | Is the exhaust system visually OK?   | (6         | SK) 🕨        | GO to B1.                                    |
|            |  |            |              | , <del></del>                                |
|            |  |            | 涿Ы           | REPLACE any collapse                         |
|            | The second secon | <b>X</b>   |              | exhaust components.                          |
|            |  |            |              | GO to B1.                                    |
| B1         | VACUUM TEST #  |            |              |  |
|            | -  |            | 2            |  |
|            | Attach a Rotunda Vacuum Gauge 059-00008 or     Attach a Rotunda Vacuum Gauge 059-00008 or  | 1 9        | <b>ド</b> ) ト | REFER to Engine/                             |
|            | equivalent to the intake manifold vacuum source.   |            | _            | Emission Diagnosis Manual* — Lack of         |
|            | Hook-up Rotunda Tachometer 059-00007 or     Applicated   |            | Ì            | power.                                       |
|            | equivalent.  | 1 6        | <b>X</b>     | GO to <b>B2</b> .                            |
|            | <ul> <li>Start engine and gradually increase speed to 2000<br/>RPM with transmission in NEUTRAL.</li> </ul>  | X          |              | GO 10 DZ.                                    |
|            |  |            | l            |  |
|            | Is neutral vacuum above 53.8 kPa (16 inches/Hg)?   |            |              |  |
| B2         | VACUUM TEST — EXHAUST DISCONNECTED #   |            |              | eg.  |
|            |  | 6          | 2            | 00 4- 50                                     |
|            | • Turn engine off.   |            | ツフ           | GO to B3.                                    |
|            | <ul> <li>Disconnect exhaust system at manifold(s).</li> </ul>  |            | X_           | GO to B4.                                    |
|            | Repeat vacuum test. Is the manifold vacuum above   |            | ツー           | GU 10 <b>54</b> .                            |
|            | 53.8 kPa (16 inches/Hg)?   |            |              |  |
| <b>B</b> 3 | VACUUM TEST — CATALYTIC CONVERTER(S) ON/   | <b>1</b> , | 1            | ÷  |
|            | MUFFLER(S) OFF #   | <i>:</i>   | 1            |  |
|            | Turn engine off.   |            | 2            | REPLACE muffler and                          |
|            | •  |            | ツー           | RETEST.                                      |
|            | <ul> <li>Reconnect exhaust system at exhaust manifold(s).</li> </ul>   |            | J            |  |
|            | <ul><li>Disconnect muffler(s).</li></ul>   |            | Ø ►          | REPLACE catalytic                            |
|            | Repeat vacuum test. Is the manifold vacuum above     100 (100 inches (100))  |            | フ・           | converter and inspect                        |
|            | 53.8 kPa (16 inches/Hg)?   |            |              | muffler to be sure converter debris has no   |
|            | and the second of the second o |            |              | entered muffler.                             |
| B4         | EXHAUST MANIFOLD RESTRICTED  |            |              | S. C. S. |
|            |  |            |              |  |
|            | <ul> <li>Remove the exhaust manifold(s). Inspect the ports</li> </ul>  | (0         | K) ►         | REFER to Engine/                             |
|            | for casting flash by dropping a length of chain into   |            |              | Emission Diagnosis<br>Manual* — Lack of      |
|            | each port. Do not use a wire or light to check ports.  The restriction may be large enough for them to   |            | - 1          | Power.                                       |
|            | pass through but small enough to cause excessive   | 4 2        | . 1          | ·  |
|            | back pressure at high engine RPM.  | 6          |              | REMOVE casting flash.                        |
|            |  | , ×        | ノー           | If flash cannot be                           |
|            | and the second second  |            |              | removed, REPLACE                             |
|            |  |            | Į.           | exhaust manifold(s) and                      |

\* Can be purchased as a separate item.

#Gasoline engine only.

CU1825-2G

### **DIAGNOSIS AND TESTING (Continued)**

Service fix for Noise—Buzz or Rattle—Loose Catalyst or Muffler Heat Shields.

NOTE: At idle or during normal driving conditions, a buzz or rattle may be detected, which can be traced to the exhaust system. The heat shield attachment to the muffler or catalyst may come free. The loose shield will vibrate off the muffler or catalyst and cause the buzz or rattle.

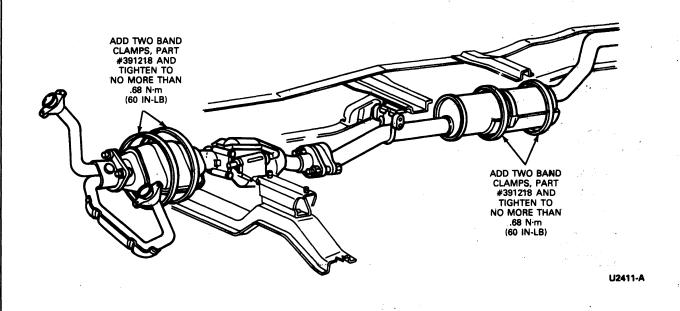
1. Attach two worm clamps (Part #391218) to the catalyst or muffler as shown in the illustration.

NOTE: The catalyst may have two cans. If shields on both cans are loose four clamps (2 of each) will be required.

Align the clamp to secure the heat shield to the muffler or catalyst.

NOTE: Torque the clamp to no more than 68 N·m (60 in-lb).

Trim excess "ear" to approximately 25.4mm (1 inch).



### **ADJUSTMENTS**

Inspect inlet pipes, outlet pipes and mufflers for cracked joints, broken welds and corrosion damage that would result in a leaking exhaust system. Inspect the clamps, brackets and insulators for cracks and stripped or badly corroded bolt threads. When pipe clamp(s) are loosened and/or removed to replace a shield, pipe or muffler, replace the clamp(s) if there is reasonable doubt that its service life is limited.

NOTE: Because mufflers are designed without drain holes, it is normal for a certain amount of moisture and staining to be present around the muffler seams. The presence of soot, surface rust, or moisture does not indicate a damaged muffler and should not constitute the basis for replacement.

Muffler clamps can be broken due to overtightening during servicing of exhaust leaks. When attempting to eliminate exhaust leaks at joints, the muffler clamp should be tightened to specification limits only. If this does not eliminate the leak, the clamp should be loosened, rotated approximately one-quarter turn, and then retightened to the specification.

The exhaust system, including brush shields, must be free of leaks, binding, grounding and excessive vibrations.

These conditions are usually caused by loose, broken or misaligned clamps, shields, brackets or pipes. If any of these conditions exist, check the exhaust system components and alignment. Align or replace as necessary.

### **Exhaust System Alignment**

Perform the following procedure to align the complete exhaust system:

- Loosen the pipe connection clamps and the pipe support bracket clamps. Loosen the inlet pipe-to-exhaust manifold attaching nuts.
- Work from the front and progressively align the exhaust system components and hangers to eliminate any interferences. Make sure that aligning tabs (if used) are fully engaged in their mating slots.

### **ADJUSTMENTS (Continued)**

3. Then working from the rear forward, retighten clamps to specifications. Finally, tighten the exhaust manifold to inlet pipe attaching nuts alternately and equally to specifications, so that the pressure on the ball flange will be uniform.

### **Brush Shield Inspection**

Raise the vehicle on a hoist. Brush shields are positioned on the underside of the catalytic converter and the muffler assembly. Shields should be free from random bends which would bring any part of the shield in soft contact with the converter or muffler assembly causing a rattle. The shield should be clear of any combustible matter.

### REMOVAL AND INSTALLATION

The exhaust system components are removed, disassembled, assembled and installed using standard tools and procedures. Only remove components to the extent necessary to replace worn or damaged components.

Always refer to the Master Parts Catalog for parts usage and interchangeability before replacing a component part of the exhaust system.

### Muffler and Outlet Pipe Assembly

### Removal

- Remove muffler and outlet pipe assembly clamp and U-bolt assemblies as required to remove worn or damaged components.
- Disconnect muffler and outlet pipe assembly bracket and insulator assemblies.
- Remove muffler and outlet pipe assembly. It may be necessary to heat the muffler / converter joint in order to separate the muffler assembly from the converter.
- On Super Cab and Crew Cab models, remove extension pipe.
- 5. If so equipped, disconnect catalytic converter bracket and insulator assembly.

NOTE: For rod and insulator type hangers, apply a soap solution to the insulator surface and rod ends to permit easier removal of the insulator from the rod end. Avoid use of oils or silicone since they do not dry and may allow the insulator to slip back off once it is installed.

- 6. Remove catalytic converter.
- On models with Managed Thermactor Air (M.T.A.), disconnect M.T.A. tube assembly.
- 8. Disconnect inlet pipe from exhaust manifold.
- 9. Remove inlet pipe assembly.

### Installation

CAUTION: Ensure positioning tabs and slots provided at the converter/muffler assembly connections are properly aligned to avoid ground out conditions with chassis components during assembly.

- On models with catalytic converter, position and install heat shields.
- Place muffler and outlet pipe assembly in vehicle by sliding in over axle housing.
- Position muffler and outlet pipe assembly by inserting it over the end of the converter and aligning slot to converter tab.
- Apply a soap solution to metal support rods on muffler and outlet pipe assembly.

NOTE: Avoid use of oils or silicone since they do not dry and may allow the insulator to slip back off once it is installed.

- Force metal support rods through rubber insulators.
- Attach hanger bracket clamps and U-bolts and tighten to specifications shown on illustration.
- Install and tighten the sealing clamp at muffler to converter joint.

CAUTION: To ensure a correctly sealed joint, the correct clamp must be used.

### **Hanger Brackets**

### Removal

- Remove muffler and outlet pipe assembly from brackets.
- Remove nuts from bracket and remove from frame.
- For F-Series rear hanger bracket, remove rivet which holds bracket to frame.

### Installation

- 1. Position bracket to frame, install and tighten nuts.
- For F-Series rear hanger bracket, position bracket on frame and attach with M10-1.5 nut and bolt. Tighten to 68-94 N·m (50-70 ft-lb).

### **Muffler Shields**

### Removal

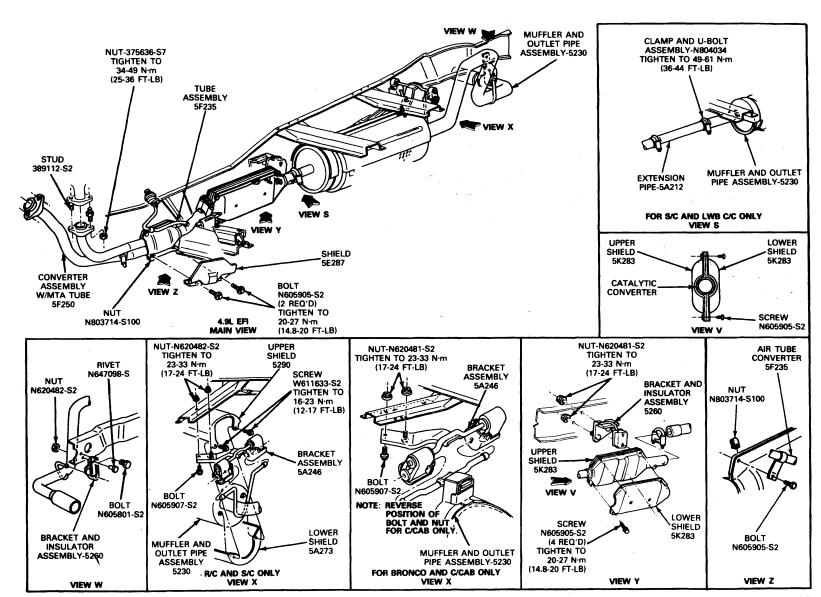
- 1. Remove band strap(s) from clamp worm gear(s).
- Remove two screws and washer assemblies which hold shield to rear of muffler.

### Installation

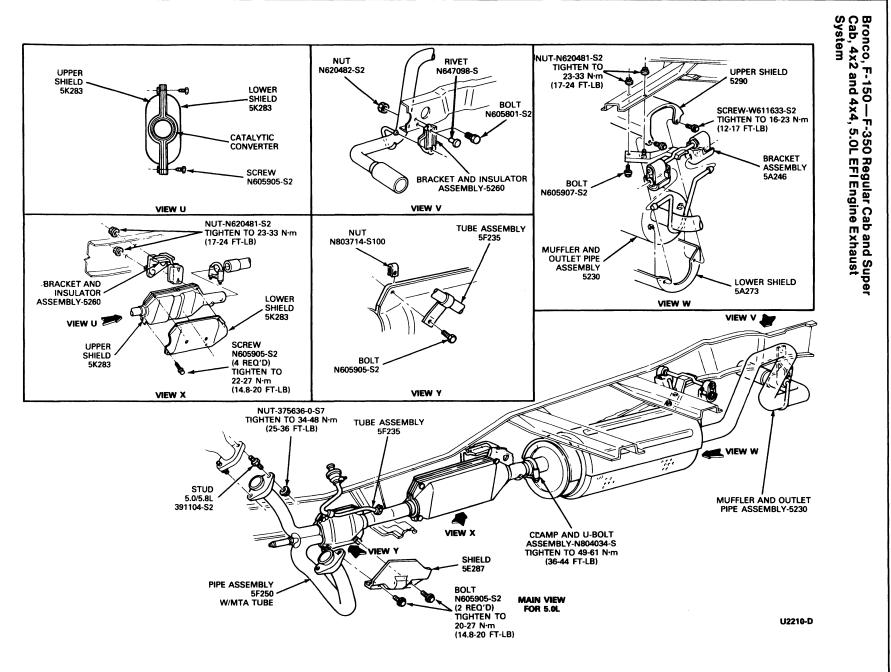
Position shield(s) on muffler body.

| <ol> <li>Install two screws to rear of muffler. Tighten<br/>screws and washer assemblies to 16-23 N·m<br/>(12-17 ft-lb).</li> </ol> | 3. Start band strap(s) in worm gear(s). Tighten to 1.8-2.3 N·m (16-20 in-lb). |  |
|---|---|--|
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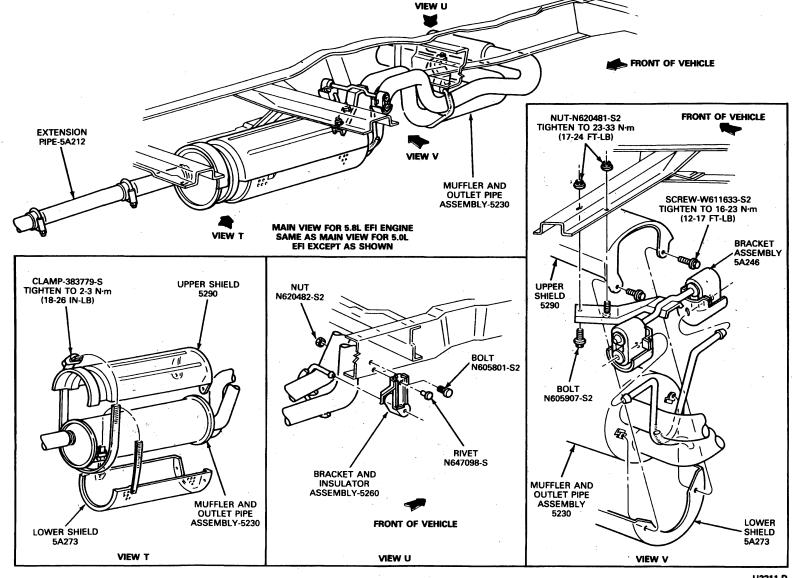
Bronco, F-150—F-350 Regular Cab, Super Cab and Chassis Cab, 4x2 and 4x4, 4.9L EFI Engine Exhaust System



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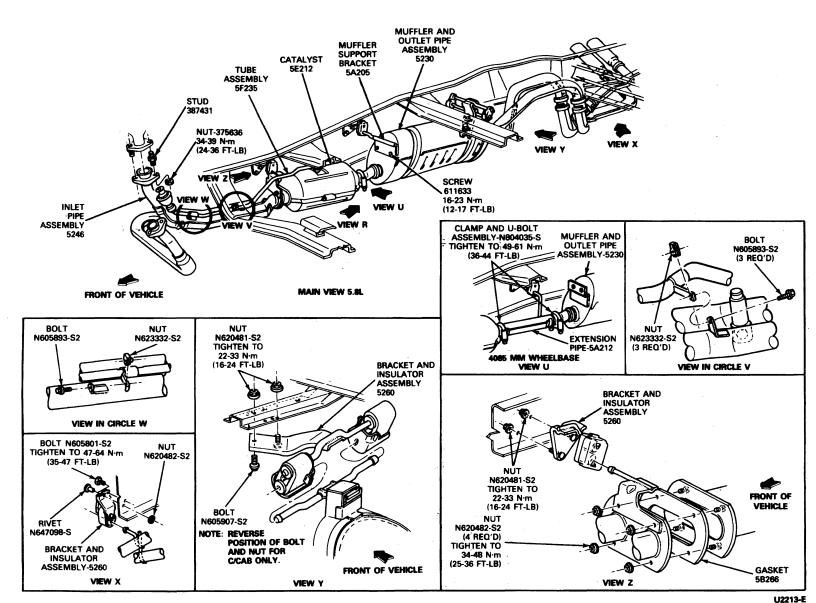


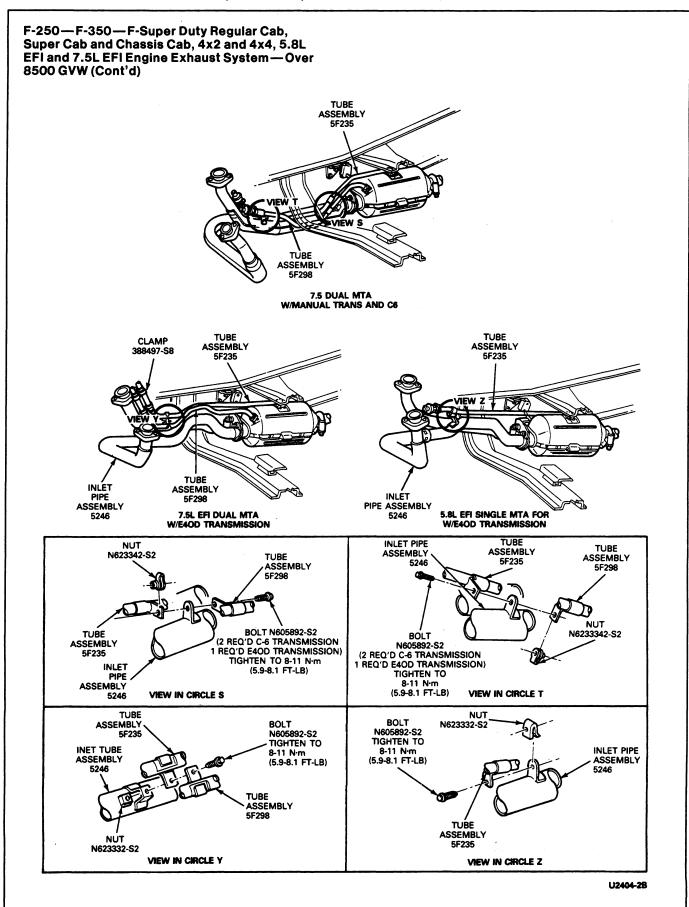




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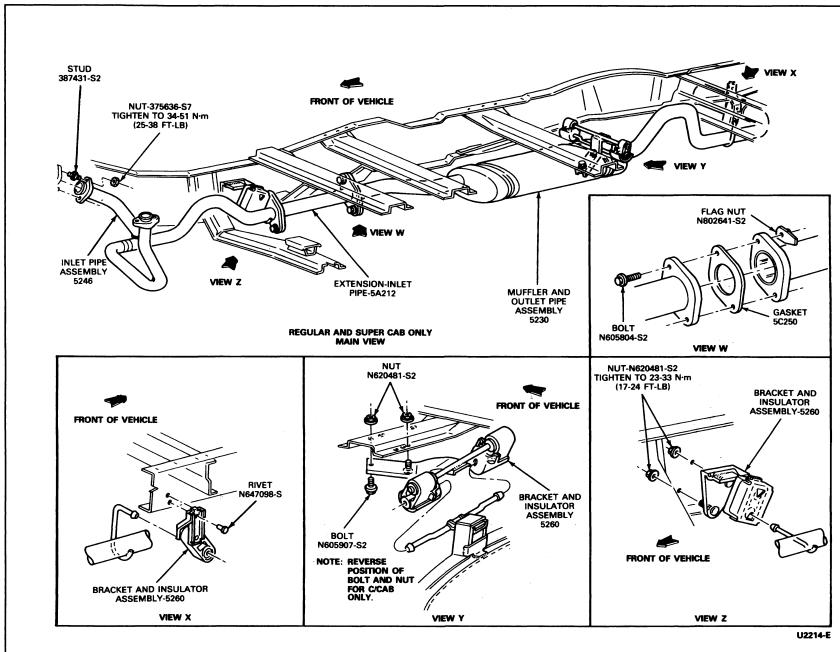
F-250—F-350—F-Super Duty Regular Cab, Super Cab and Chassis Cab, 4x2 and 4x4, 5.8L EFI and 7.5L EFI Engine Exhaust Systems—Over 8500 GVW

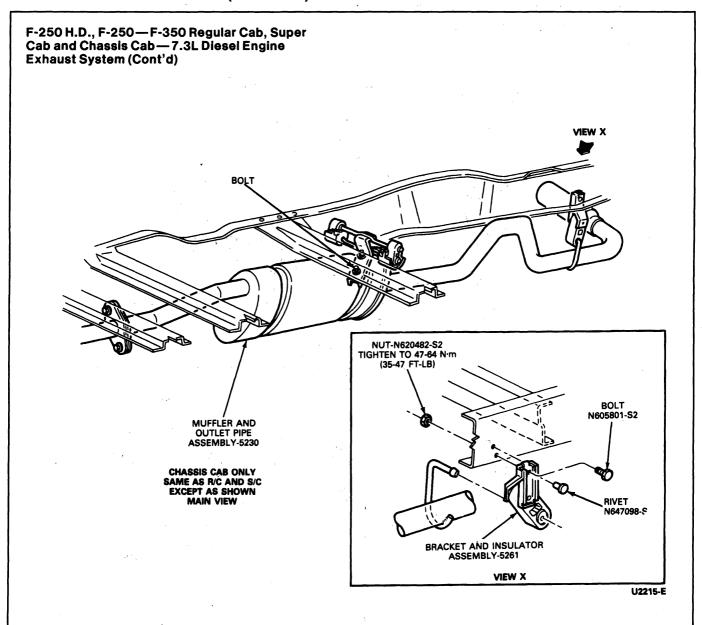


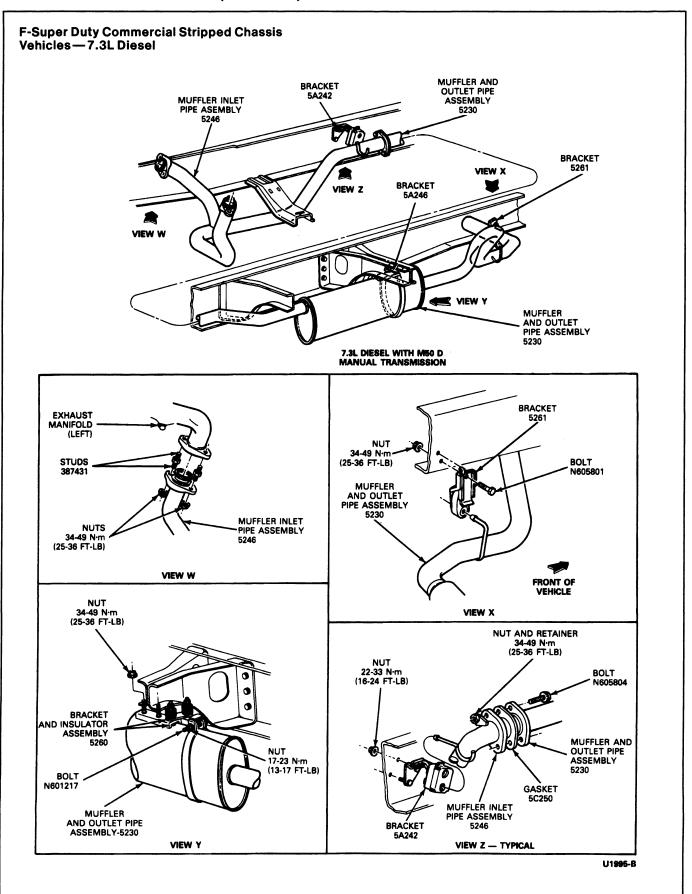


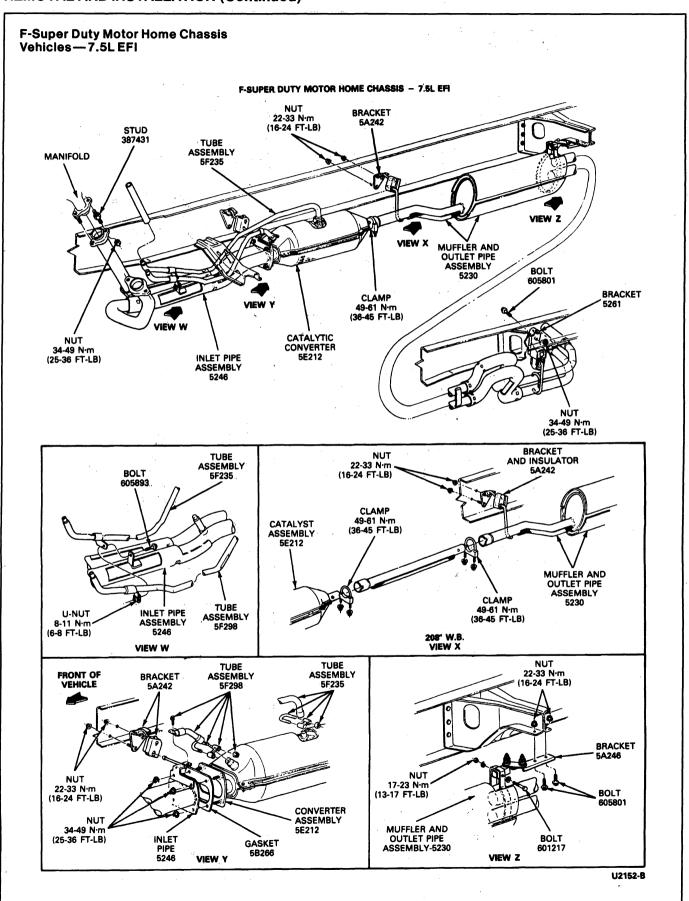
### **REMOVAL AND INSTALLATION (Continued) Exhaust System**

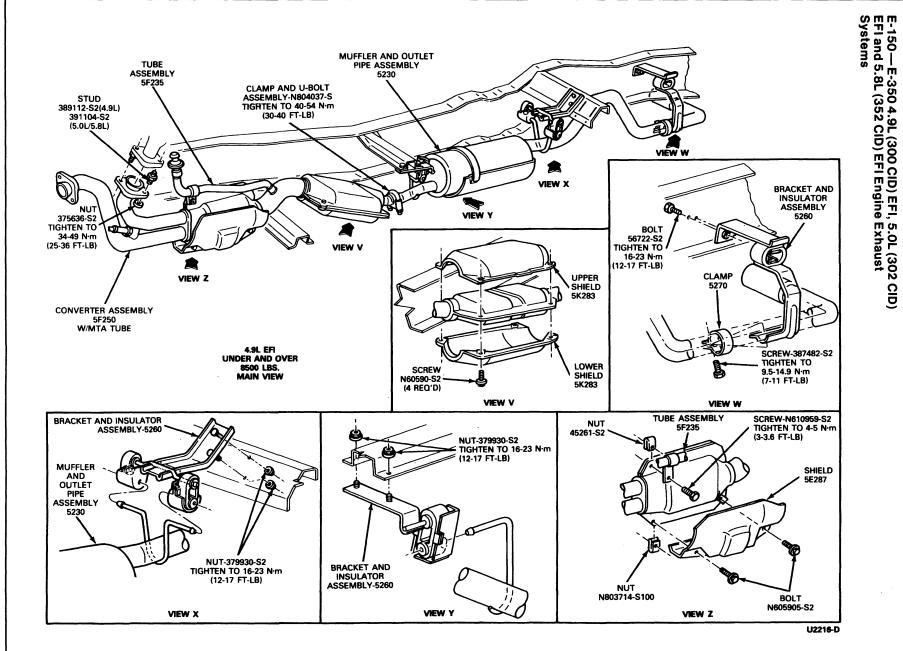
F-250—F-350 Regular Cab, Super Cab and Chassis Cab—7.3L Diesel Engine Exhaust System

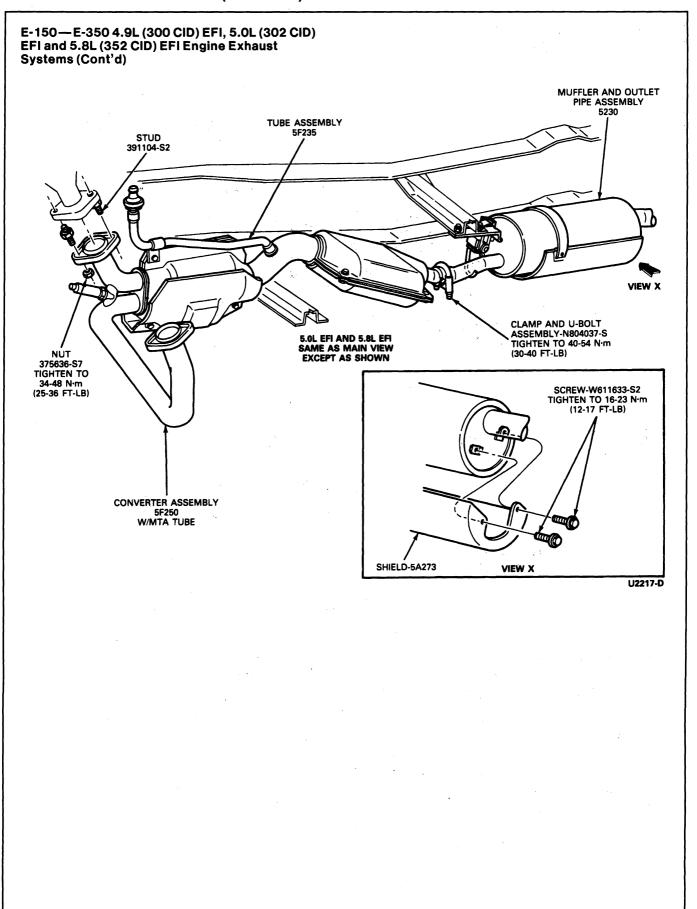


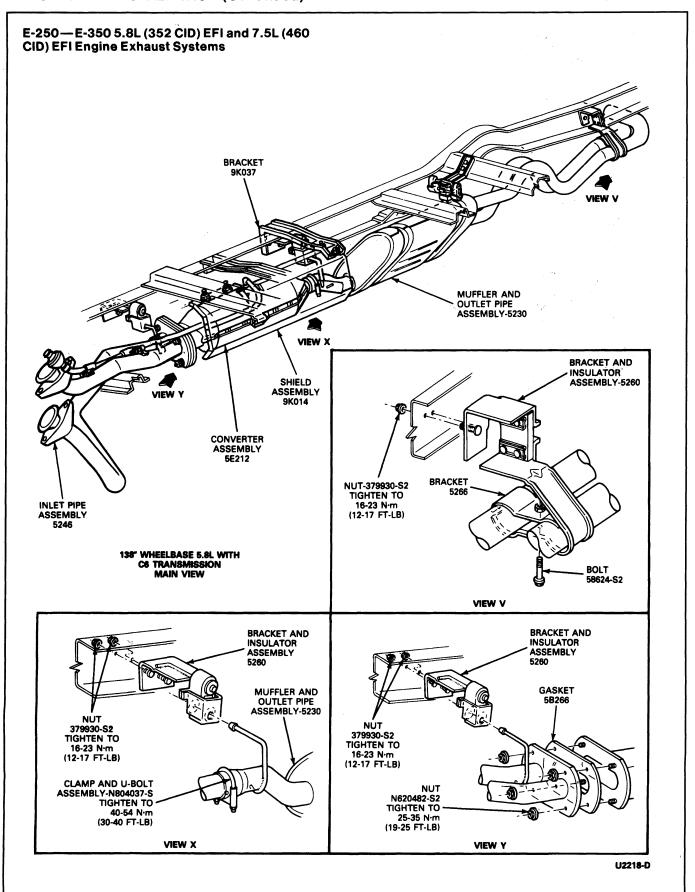


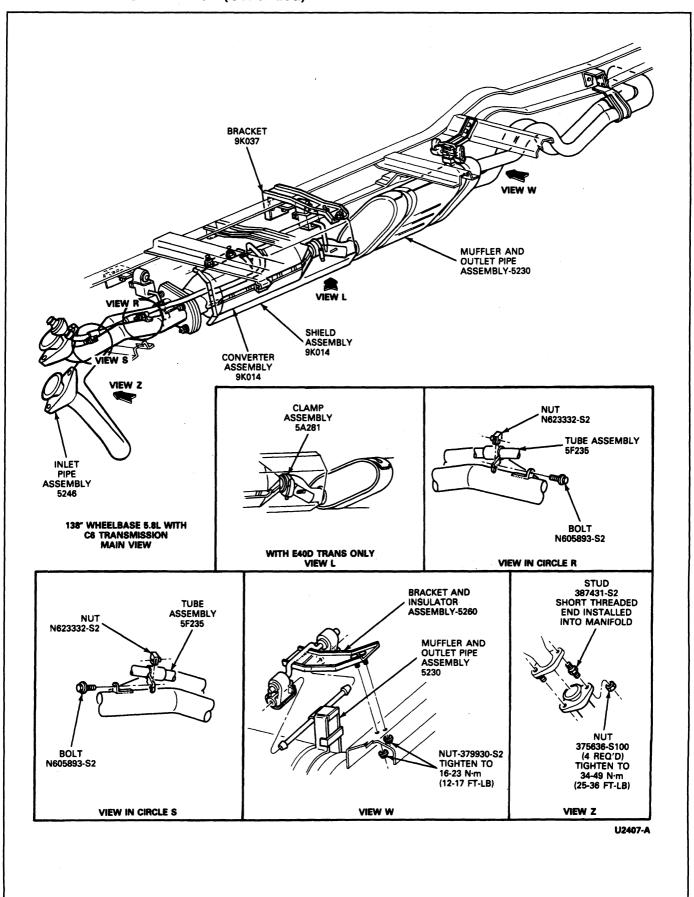




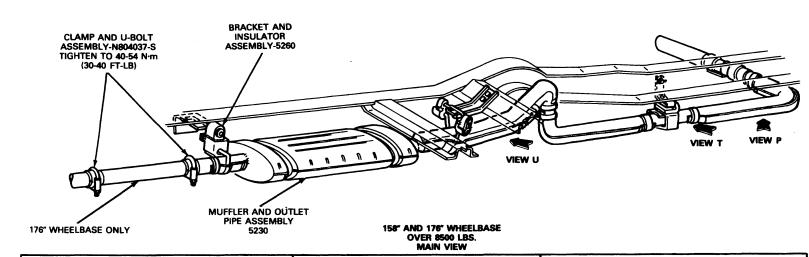


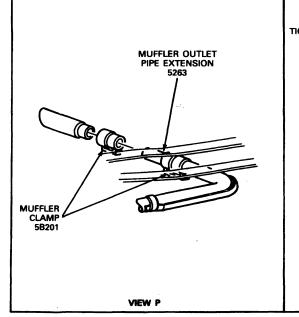


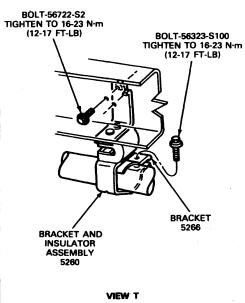


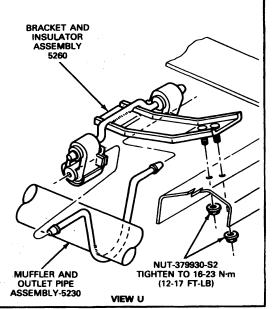


E-250—E-350 5.8L (352 CID) EFI and 7.5L (460 CID) EFI Engine Exhaust Systems (Cont'd)

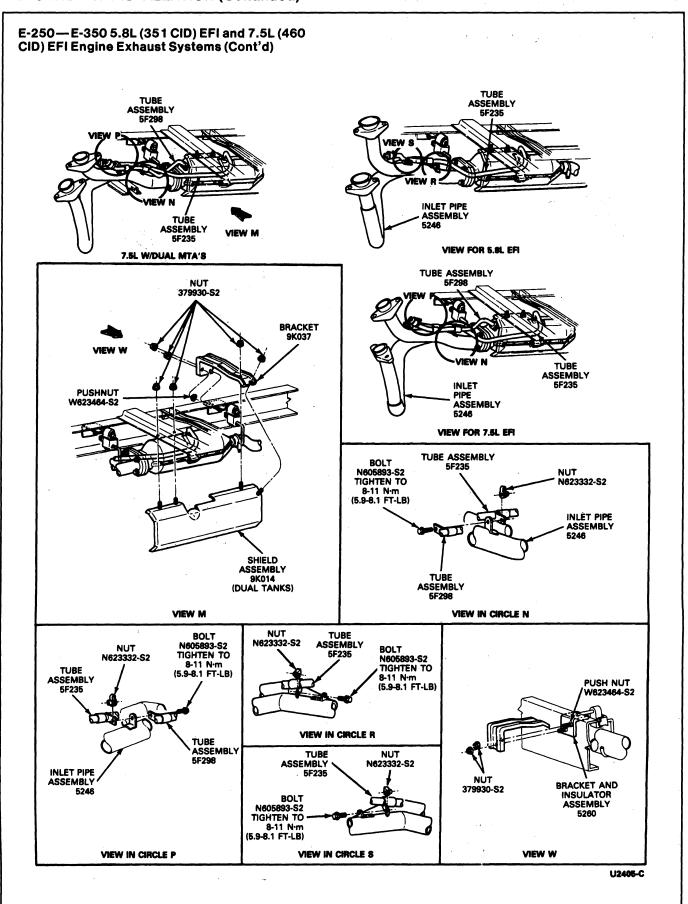




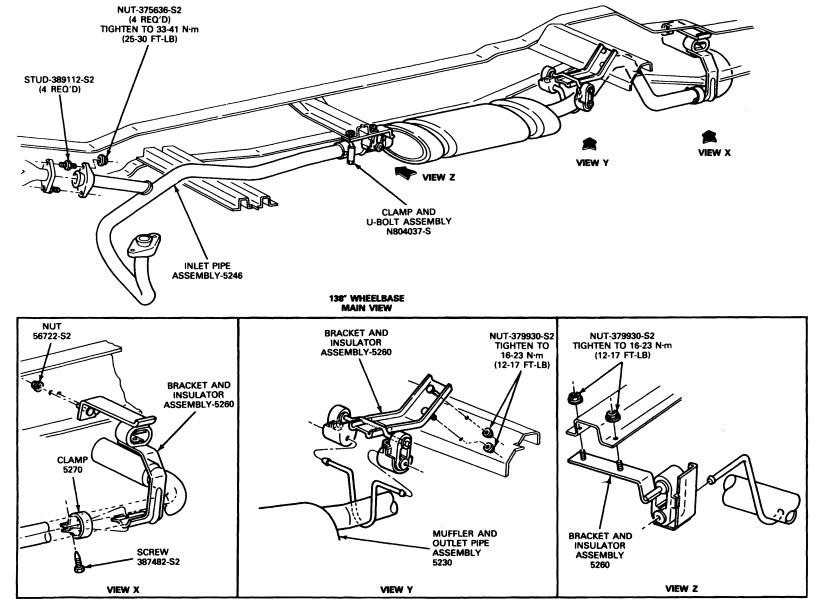




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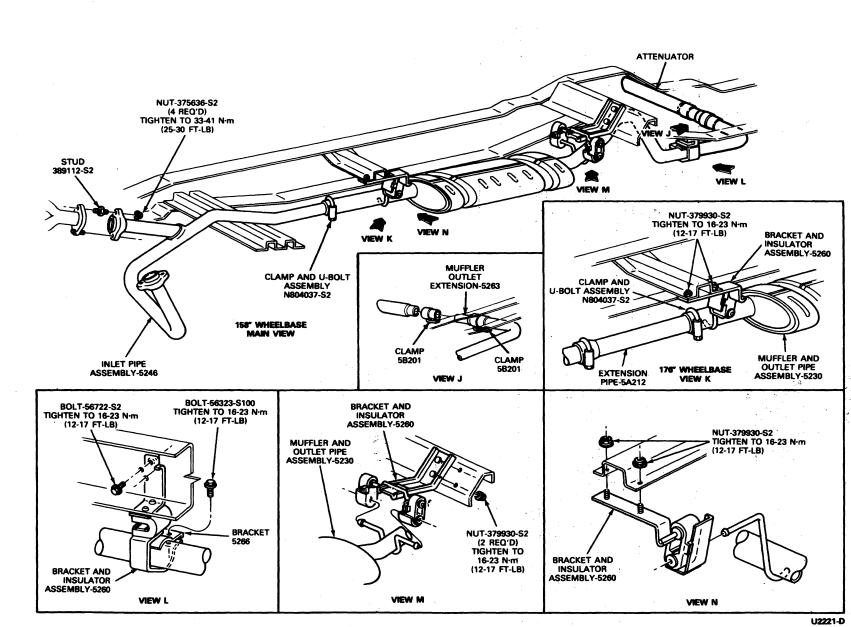


E-250 Heavy Duty—E-350 7.3L Diesel Engine Exhaust Systems



U2220-D





### **SPECIFICATIONS**

### TORQUE LIMITS — EXHAUST SYSTEM BOLTS AND NUTS —

UNLESS OTHERWISE SPECIFIED, THE FOLLOWING TORQUE RANGES ARE TO BE USED FOR FITTING OR FASTENER DIAMETERS AS INDICATED.

| Bolt or  | Torque Range  |                         | Torque Range |  |
|--|---|-------------------------|--------------|--|
| Nut Diameter   | Class 9.8 (Grade 5)   | Class 10.9 (Grade 8)    |              |  |
| 8mm (5/16 inch)<br>10mm (3/8 inch)<br>12mm (7/16 inch) | 20-27 N-m (14-19 ft-lb)<br>37-50 N-m (28-36 ft-lb)<br>65-90 N-m (48-66 ft-lb) | 47-64 N·m (34-47 ft-ib) |              |  |

CU1988-1B

| item :  | Torque |       |
|---|--------|-------|
|   | N·m    | Ft-Lb |
| Inlet Pipe to Exhaust Manifold                                      | 34-39  | 25-36 |
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CU2205-B

### **SPECIAL SERVICE TOOLS**

### **ROTUNDA EQUIPMENT**

| Model     | Description  |
|-----------|--------------|
| 059-00008 | Vacuum Gauge |
| 059-00007 | Tachometer   |

CU2369-1A

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| Regulator Valve)10-01A-12                     |   |
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| 200.0   | Fuel Tubes Bleetie  |

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### **VEHICLE APPLICATION**

E-150—E-350, F-150—F-350, F-Super Duty and Bronco Vehicles with Gasoline Engines

### **DESCRIPTION**

### **Electronic Fuel Injection (EFI)**

F-Series, Bronco and Econoline vehicles are equipped with EFI engines, which are fuel injected through an engine-mounted fuel rail with a fuel injector located in the intake port of each cylinder. The fuel systems which are used on E-Series with fuel injected engines have electric fuel pumps to provide high pressure fuel to the injectors.

The electric fuel delivery system used on the F-Series / Bronco Electronic Fuel Injection (EFI) engines consists of a fuel delivery module (FDM) assembly. The FDM system achieves a significant reduction in fuel system complexity and simplifies fuel line routing. The in-line filter is located on the left-hand frame rail to provide service access.

The fuel lines leading from the fuel tank to the engine are under pressure during vehicle operation. When fuel injected engines are turned off, the fuel in the fuel lines remains pressurized for long periods of time to provide quick start-ups. Special procedures for servicing these pressurized fuel systems are outlined.

NOTE: F-Super Duty Motorhome chassis uses a high-pressure in-tank fuel pump with the filter located on the LH frame rail near the rear of the transmission.

The fuel system on E-Series and F/B Series have electric fuel pumps. The Econoline uses a low pressure boost pump located in the fuel tank and a high pressure fuel pump mounted on the frame rail. The F-Series and Bronco use the described FDM system.

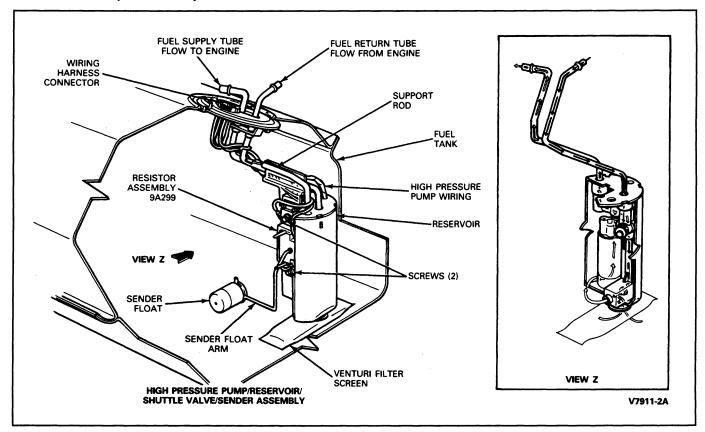
### Fuel Filters—Gasoline Engines

The in-line fuel filter provides filteration to protect the small metering orifices of the injector nozzles. The filter assembly (F-Series and Bronco) and filter pump assembly (E-Series) is located on the left-hand frame rail

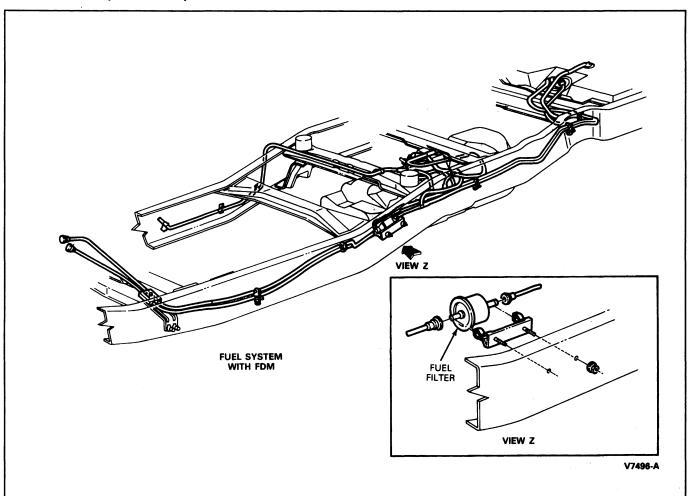
NOTE: The filter should last the life of the vehicle under normal driving conditions. If the filter does not need to be replaced, proceed to Fuel Filter—In-Line Type—4.9L HS, 5.0L, 5.8L and 7.5L EFI Engines in the Removal and Installation portion of this section.

### F-Series and Bronco Fuel Pump—Electric (FDM)

The electric fuel delivery system used on the 4.9L, 5.0L, 5.8L and 7.5L Electronic Fuel Injection (EFI) engines consists of a fuel delivery module (FDM) assembly. The FDM unit includes a high pressure fuel pump, venturi jet pump, supply check valve, and a shuttle selector valve all located internally to an in-tank reservoir assembly mounted from the fuel tank sender flange. The fuel sending unit is attached to the reservoir body and is a separately serviceable component.



In addition, the FDM system achieves a significant reduction in fuel system complexity and simplifies fuel line routing. The in-line fuel filter is located on the left-hand frame rail to provide service access.



### Fuel Delivery Module (FDM)—F-Series and Bronco

The following provides a brief description of each of the internal components functions.

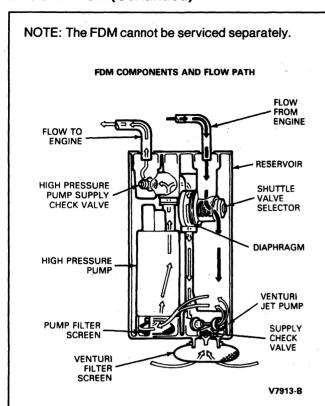
High Pressure Fuel Pump: The high pressure fuel pump is located inside the flange mounted, reservoir assembly internal to the fuel tank. The in-tank, high pressure pump replaces the need for a two pump fuel delivery system which requires a low pressure pump in the tank combined with a frame mounted high pressure pump.

Shuttle Selector Valve: The shuttle selector valve opens the return line to the tank when the diaphragm force, resulting from the fuel pressure applied to the shuttle diaphragm, exceeds the opposing spring force. Thus, the return flow is directed to the appropriate tank on vehicles equipped with dual tanks.

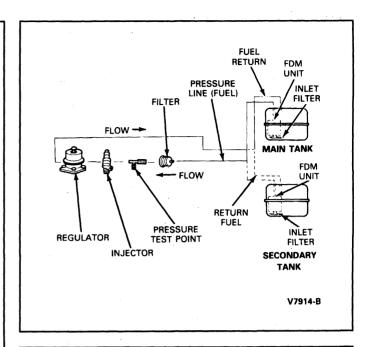
Supply Check Valve: The supply check valve, which is normally closed, opens when the outlet pressure from the energized pump exceeds the opposing check valve spring force. When the pump is de-energized (i.e., engine is shut-off), the supply check valve closes to maintain pump prime and fuel supply line pressure.

Venturi Jet Pump: A portion of the high pressure flow from the pump is diverted to operate the venturi jet pump. The venturi pump draws fuel from the tank into the FDM reservoir to augment the engine return flow. This process ensures an adequate fuel supply to the pump during extreme vehicle maneuvers and steep vehicle attitudes with low-tank fill levels.

The inlet of the venturi pump has a nylon filter on it to prevent dirt and other particulate matter from entering the system. Any water accumulation in the fuel tank can pass through the filter without restriction.



The in-tank mounted high pressure fuel pump is capable of supplying 105 liters (27.7 gallons) of fuel per hour at a working pressure of 270.0 kPa (39 psi) for the 5.0L, 5.8L and 7.5L EFI engines. The pump can supply 90 liters (23.7 gallons) per hour at 380 kPa (55 psi) for the 4.9L EFI engine. The pump has an internal pressure relief valve to provide overpressure protection in the event the fuel flow becomes restricted. Overpressure is restricted to 850 kPa (123 psi) and reduced fuel flow will result. The system pressure is controlled by a pressure regulator on the engine.

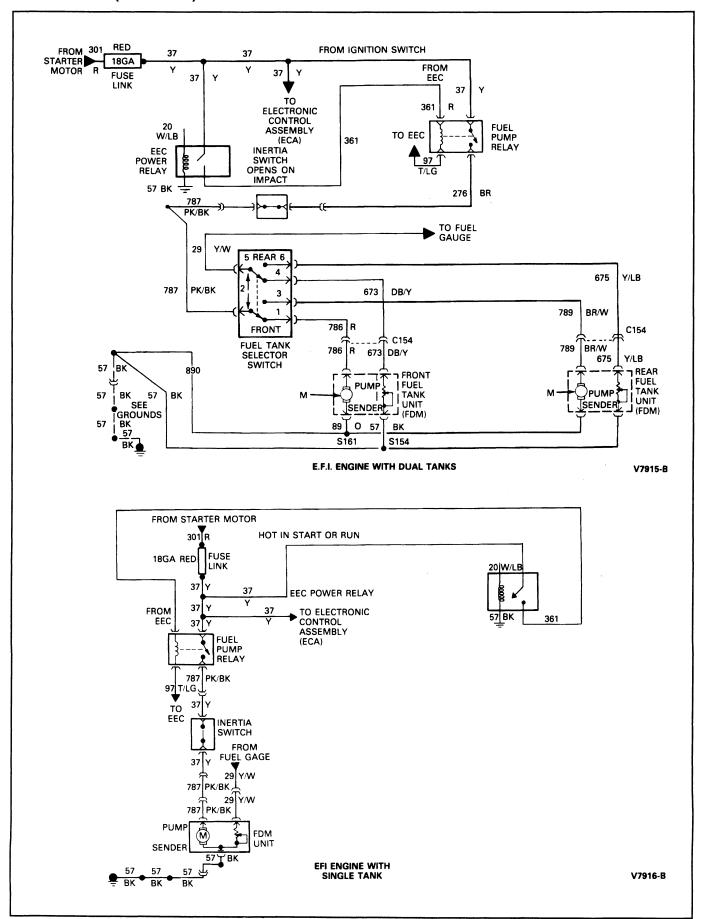


### Fuel Delivery Module (FDM) Control—F-Series and Bronco

When the ignition switch is turned to the ON position, the Electronic Engine Control (EEC) power relay is energized and provides power to both the fuel pump relay and a timing device in the EEC processor. Fuel pump power is provided through the contacts of the fuel pump relay and the inertia switch. If the ignition switch is not turned to the START position within approximately one second, the timing device in the EEC processor will open the ground circuit (No. 97 T/LG) to the fuel pump relay. Opening the ground circuit de-energizes the fuel pump relay (opening its contacts), which de-energizes the fuel pumps. This circuitry pressurizes the fuel system.

When the ignition switch is turned to the START position, the EEC processor energizes the fuel pump relay to provide fuel while cranking.

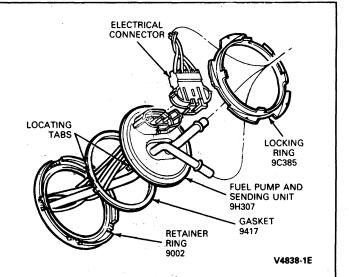
After the engine starts, the ignition switch is returned to the ON position, the power to the fuel pump is supplied through the fuel pump relay. The EEC processor senses speed and shuts off the fuel pump by opening the ground circuit (No. 97 T/LG) to the fuel pump relay if the engine stops or engine speed drops below 120 rpm.



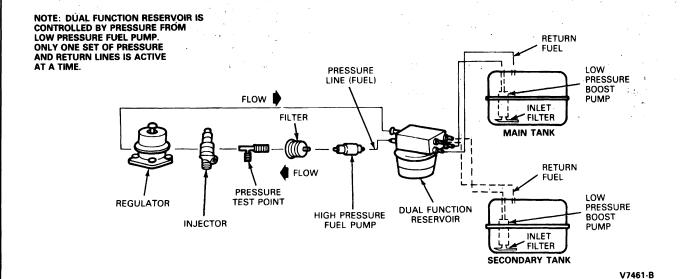
### Fuel Pump—Electric—Econoline

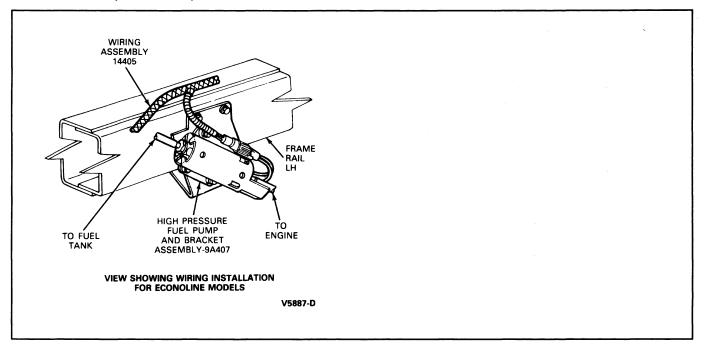
The electric fuel pump system used on the 4.9L, 5.0L, 5.8L and 7.5L Electronic Fuel Injection (EFI) engines consist of two fuel pumps: a low pressure boost pump mounted in the fuel tank, and a high pressure fuel pump mounted on the frame rail. An in-line reservoir is located at the high pressure pump inlet. This design provides for satisfactory fuel pump operation during extreme vehicle maneuvers and steep vehicle attitudes with low-tank fill levels.

The low pressure electric fuel pump is used to provide pressurized fuel to the inlet of the high pressure pump and helps prevent noise and hot fuel concerns. The inlet of the low pressure fuel pump has a nylon filter on it to prevent dirt and other particulate matter from entering the system. Any water accumulation in the fuel tank can pass through the filter without restriction.



The high pressure fuel pump is capable of supplying 80 liters (21.2 gallons) of fuel per hour at a working pressure of 269.0 kPa (39 psi) for the 5.0L and 5.8L EFI engines and 379.2 kPa (55 psi) for the 4.9L EFI engine. The pump has an internal pressure relief valve to provide overpressure protection in the event the fuel flow becomes restricted. Overpressure is restricted to 950 kPa (138 psi) and reduced fuel flow will result. The system pressure is controlled by a pressure regulator on the engine.



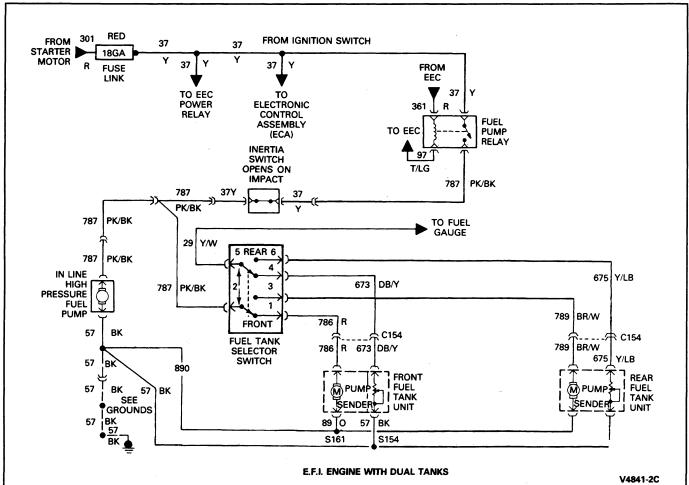


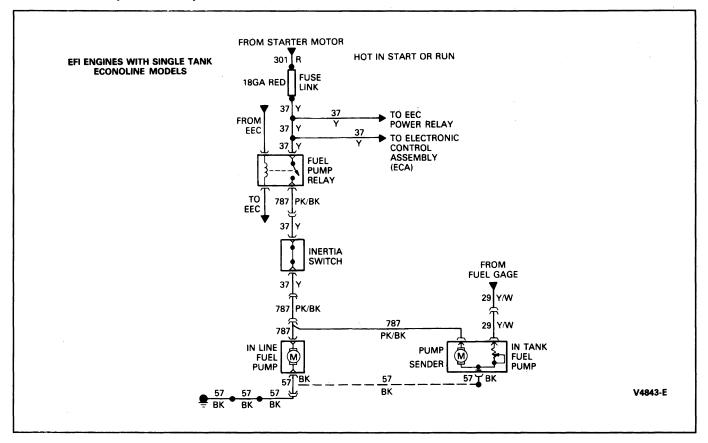
### Fuel Pump Control—Econoline

When the ignition switch is turned to the ON position, the Electronic Engine Control (EEC) power relay is energized and provides power to both the fuel pump relay and a timing device in the EEC processor. Fuel pump power is provided through the contacts of the fuel pump relay and the inertia switch. If the ignition switch is not turned to the START position within approximately one second, the timing device in the EEC processor will open the ground circuit (No. 97 T/LG) to the fuel pump relay. Opening the ground circuit de-energizes the fuel pump relay (opening its contacts), which de-energizes the fuel pumps. This circuitry pressurizes the fuel system.

When the ignition switch is turned to the START position, the EEC processor energizes the fuel pump relay to provide fuel while cranking.

After the engine starts, the ignition switch is returned to the ON position, and power to the fuel pump is supplied through the fuel pump relay. The EEC processor senses speed and shuts off the fuel pump by opening the ground circuit (No. 97 T/LG) to the fuel pump relay if the engine stops or engine speed drops below 120 rpm.





### **Fuel Lines**

Fuel lines are pressurized for electronically fuel injected engines. The fuel lines, hoses and connections used with these various systems are as follows:

### **Pressurized Fuel Systems**

Nylon and steel fuel tubes with push connect fittings are used on 4.9L, 5.0L, 5.8L and 7.5L EFI engines.

### **Fuel Evaporative Emission System**

The evaporative emission system limits the amount of fuel vapor a vehicle may release to the atmosphere, enabling the vehicle to meet current federal and state requirements for fuel evaporation. The system works by capturing a very high percentage of fuel vapors that might otherwise escape from the gas tank. It then directs these vapors to the carbon canister where they are stored while the engine is not running. When the engine is running, and conditions are acceptable, the vapors are purged out of the canister and into the engine. This "clears" the canister and allows it to accept more fuel vapors the next time the engine is shut off.

The system is basically the same for all vehicle and engine lines: a hose or tube runs from the top of the fuel tank to the carbon canister to allow fuel vapors to pass from the tank to the carbon canister. A tube or hose runs from the carbon canister to the engine, allowing vapors to be purged from the canister. Some engines use additional valves in one or more of these lines to provide additional control over how much or when fuel vapor will be allowed to pass.

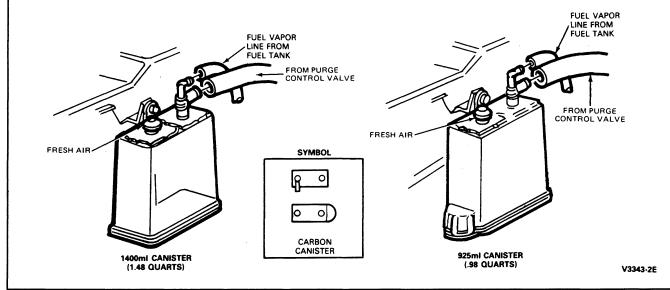
The following are components of the evaporative emission system:

- Sealed Fuel Tank
- Pressure Vacuum Relief Fuel Cap
- Fuel Tank Vapor Valve
- Carbon Canister
- Purge Control Valve
- Canister Purge Solenoid or Purge Regulator Valve (Some Engines)
- Vacuum Bowl Vent Valve (Some Engines)
- Vacuum Thermal Bowl Vent Valve (Some Engines)
- Pressure Regulator Valve (Some Engines)
- Tank Vapor Valve—Orifice Rollover Valve

### **Carbon Canister**

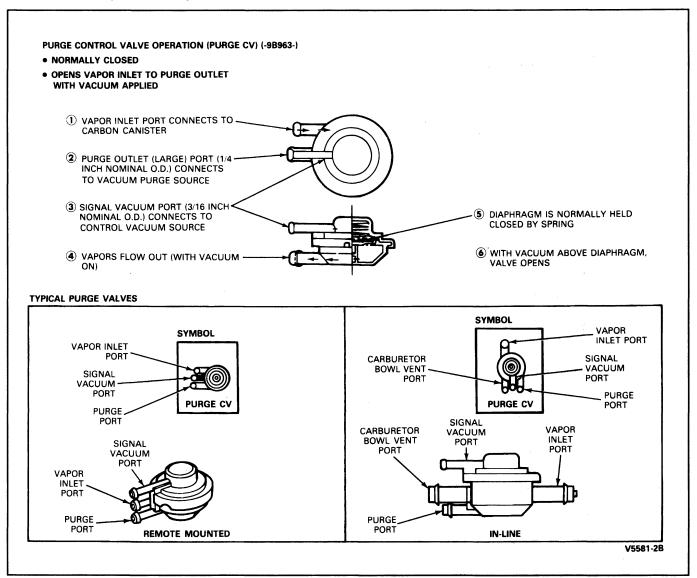
Typical carbon canisters are shown in the following illustration. The carbon canister is normally mounted in or near the engine compartment. Two basic sizes are employed: 925ml or 1400ml. The "925" and "1400" refer to volume of activated carbon contained within the canister. Activated carbon is the working part of the carbon canister. It has the unique ability to absorb (store) and purge (remove) fuel vapors by passing fresh air through the carbon bed. It is able to do this over and over with almost no loss in ability to absorb and purge.

Thus, all sources of fuel vapor (fuel tank and carburetor fuel bowl) are routed to the carbon canister for absorption of fuel vapor.



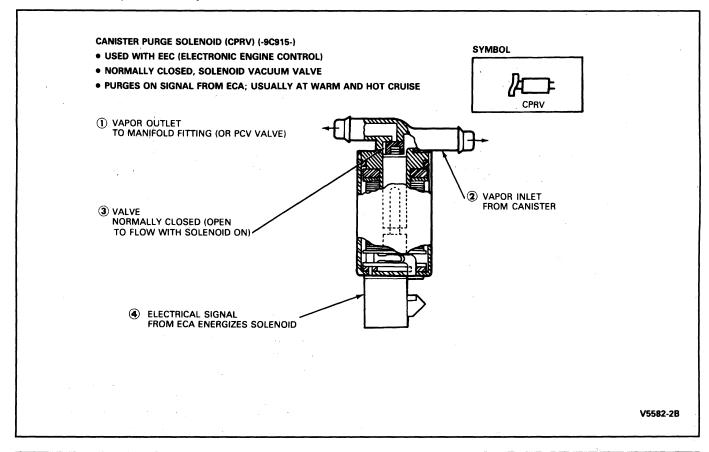
### Canister Purge Control Valve (Non-Electrical Control)

The purge control valve is in line with the carbon canister and controls the flow of fuel vapors out of the canister. It is a normally closed valve that opens with vacuum input. Operation of the valve is shown in the following illustration. Also shown are views of typical purge control valves.



### Canister Purge Solenoid (Canister Purge Regulator Valve)

A typical canister purge solenoid is shown in the following illustration. The canister purge solenoid is a normally closed valve. The valve is connected in line between the carburetor spacer nipple and the carburetor bowl vent hose.



The operation of the canister purge solenoid is controlled by the electronic control assembly (ECA) for vehicles with EEC-IV. When the engine is off, the canister purge solenoid is not energized and is in a closed, non-flowing condition. When the engine is running, the ECA reads engine RPM, engine load, engine temperature and other variables, and decides the proper time for the engine to accept fuel vapors. When this occurs, the ECA energizes the canister purge solenoid, allowing flow from the carbon canister to the intake manifold. The vapors are then consumed in the engine. This action "purges" the carbon canister of fuel vapors. It occurs as fresh air is sucked into the carbon canister under the fresh air inlet cap of the canister and through the activated carbon bed. This allows the stored fuel vapors to pass from the canister through the fuel vapor return tube and the canister purge solenoid, and into the engine.

### Fill Control/Vent

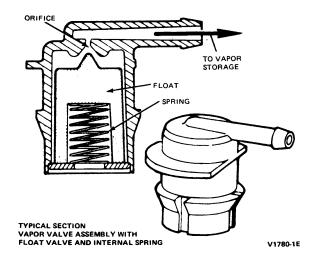
Fill limiting is accomplished through fill pipe configuration and/or external vent lines within the fill pipe and tank. The vent system is designed to permit at least 10 percent tank volume air space when the tank is filled to capacity. This air space provides for thermal expansion of fuel as well as being an aid to the in-tank vapor vent system.

### Vapor Vent—In-Tank Venting

This system provides a vapor space above the gasoline surface in the fuel tank. This area is sufficient to permit adequate breathing space for the tank vapor valve assembly under all static and most dynamic conditions. This is accomplished by the tank vapor valve assembly that is centrally located on the upper surface of the tank.

### Tank Vapor Valve—Orifice Rollover Valve Assembly

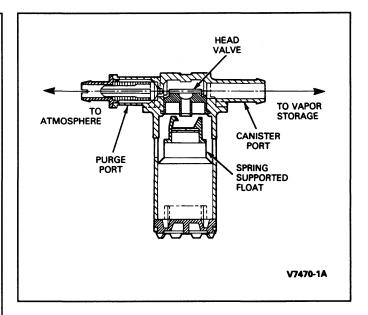
All fuel tank vapor valves make use of a small orifice that tends to allow only vapor and not fuel to pass into the line running forward to the vapor storage canister. This assembly mounts directly to the fuel tank using a rubber seal.



Fuel vapors trapped in the sealed fuel tank are vented through the orificed vapor valve assembly in the top of the tank. The vapors leave the valve assembly through a single vapor line and continue to the carbon canister for storage, until they are purged to the engine.

### Mechanical Rollover Valve—5.8L EFI and 7.5L EFI Engine

The vapor valve assembly mounted on the top of the fuel tank is used to control the flow of fuel vapor entering the fuel tank vapor delivery line which conducts vapor forward to the canister in normal circumstances. If due to extreme conditions, excessive pressure is generated inside the tank, the purge port opens up, allowing fuel vapor to escape to the atmosphere, and stabilizes pressure inside the tank. The valve assembly has a head valve which prevents the fuel tank from overfilling during refueling operation. The valve assembly also has a spring supported float assembly, which prevents liquid fuel from entering the vapor delivery line during severe handling, steep grades or in the event of vehicle rollover.



### Pressure and Vacuum Relief System Fuel Fill Cap

The fuel fill cap is sealed and includes a built-in pressure-vacuum relief valve. Fuel system vacuum relief is provided after 3.5 kPa (0.50 psi) and pressure relief after 11.0 kPa (1.6 psi). Under normal operating conditions, the fill cap operates as a check valve, allowing air to enter the tank as fuel is used, while preventing vapors from escaping the tank through the cap.

NOTE: Use of an aftermarket fuel fill cap other than an authorized Ford / Motorcraft service part could result in damage to the fuel system or improper system operation if not properly designed / manufactured for pressure vacuum relief. Customer warranty is void for fuel tank and / or fuel system damage resulting from the use of such caps.

### **Fuel Line Routings**

Refer to the illustrations throughout this section for fuel line routings and tank installations.

### Gasoline Octane Rating

Vehicles equipped with catalytic converters must use UNLEADED GASOLINE ONLY (as specified on the fuel gauge or adjacent to the fuel filler opening). Leaded gasoline can damage the catalytic converter and affects other emission components. When the engine is adjusted to recommended specifications, you may use a gasoline with a minimum octane rating as designated by any of the following numbers:

- Research Octane Number (RON). .91
- Average of Research Octane Number and Motor Octane Number
- (Antiknock Index)......87

Octane rating and unleaded gasoline availability may vary between gasoline stations.

### **Fuel Tank Filling**

The filler tube openings for the fuel tanks on trucks with electronic fuel injection (EFI) engines have been made smaller to prevent accidental filling with other than unleaded fuel. Gasoline pumps in the United States and Canada dispensing unleaded fuel are equipped with nozzles to accommodate the smaller filler opening on the filler neck.

Expansion of fuel due to temperature increases, or overfilling ("topping off") causes fuel overflow at the filler cap when the vehicle is standing or the cap is removed. To minimize this condition, it is recommended that the amount of fuel put in the tank when filling be limited to the automatic pump shutoff. If vehicle has two tanks, use fuel from both tanks after fill-up to reduce fuel levels.

### **Fuel Tank Draining**

Use appropriate adapter to connect Rotunda Fuel Storage Tanker 034-00002 or equivalent suction pump, to the fuel hose (at the fuel pump to fuel tube connection) and drain the fuel tank.

### Fuel Selector Valve/Dual Function Reservoir

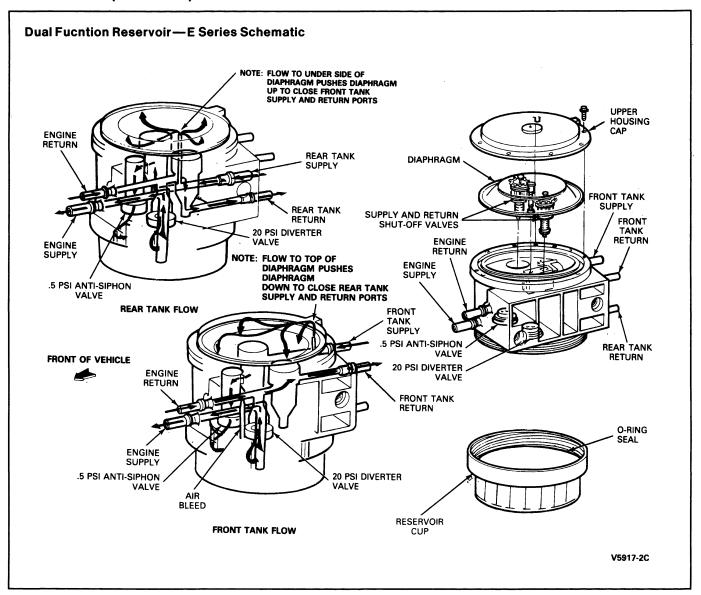
The 4.9L EFI, 5.0L EFI, 5.8L EFI, or 7.5L EFI engine (used on Econoline) with dual tanks has three electric fuel pumps. Two low pressure in-tank fuel pumps, located in both the front and rear tanks, pump fuel into a reservoir. A high pressure in-line fuel pump then takes the fuel from the reservoir to the fuel injectors.

This system can draw fuel from either the front or rear fuel tank unit. With the ignition switch in START or RUN, current flows through a fuse link to the fuel pump relay.

The dual function reservoir operates as follows:

Fuel pressure created by the selected in-tank fuel pump exerts force on a 3 inch fluorosilicon diaphragm which is in turn connected to a T-bar and two shafts. This force moves the valve shaft, simultaneously opening and closing the appropriate supply and return ports. When the alternate fuel tank is selected, pressure is exerted on the opposite side of the diaphragm, moving the valve shafts to open the alternate fuel tank ports.

#### **DESCRIPTION (Continued)**



#### **Fuel Reservoir**

The EFI engine with its fuel injectors has eliminated the requirement of the conventional carburetor bowl that is present on carbureted engines. One function that the carburetor bowl performed was to act as a fuel reservoir or fuel supply source for the engine when the in-tank fuel pick-up tube was exposed to the air during cornering or on steep grades under low fuel conditions. Any time the pick-up tube on an EFI engine without a fuel reservoir is exposed to the air, fuel starvation will occur.

To solve this, an in-line reservoir has been included in the Econoline fuel system. Under normal operating conditions, valving in the in-line reservoir allows the high-pressure pump and engine to be supplied with fuel directly from the tank while return flow is routed directly back to the tank. When the pick-up tube is exposed to air, the high pressure pump draws fuel from the reservoir. When the pick-up is again submerged, normal operation resumes.

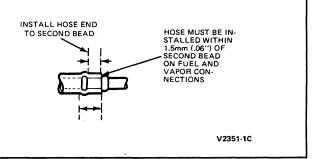
There are two types of reservoirs—single function and dual function. A single function reservoir is used with single tank vehicles. The dual function reservoir is used with dual tank vehicles. A dual function reservoir combines the function of the reservoir with the function of a separate selector valve.

NOTE: The F-Super Duty Motorhome chassis fuel reservoir is integral with the fuel tank.

# **DESCRIPTION (Continued)**

#### **Vapor Hoses**

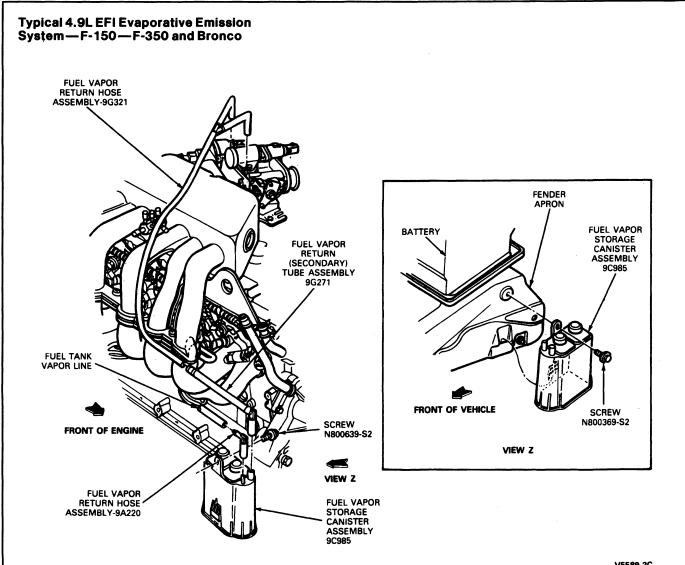
Vapor hoses should be assembled with the minimum engagement shown in the following illustration.



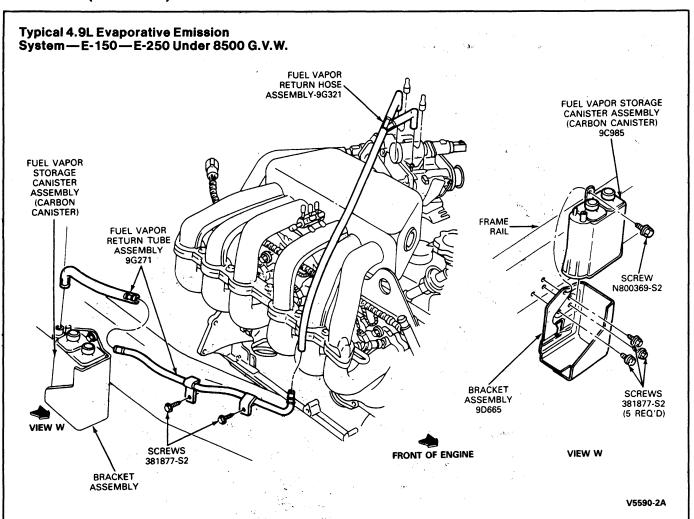
#### **DIAGNOSIS**

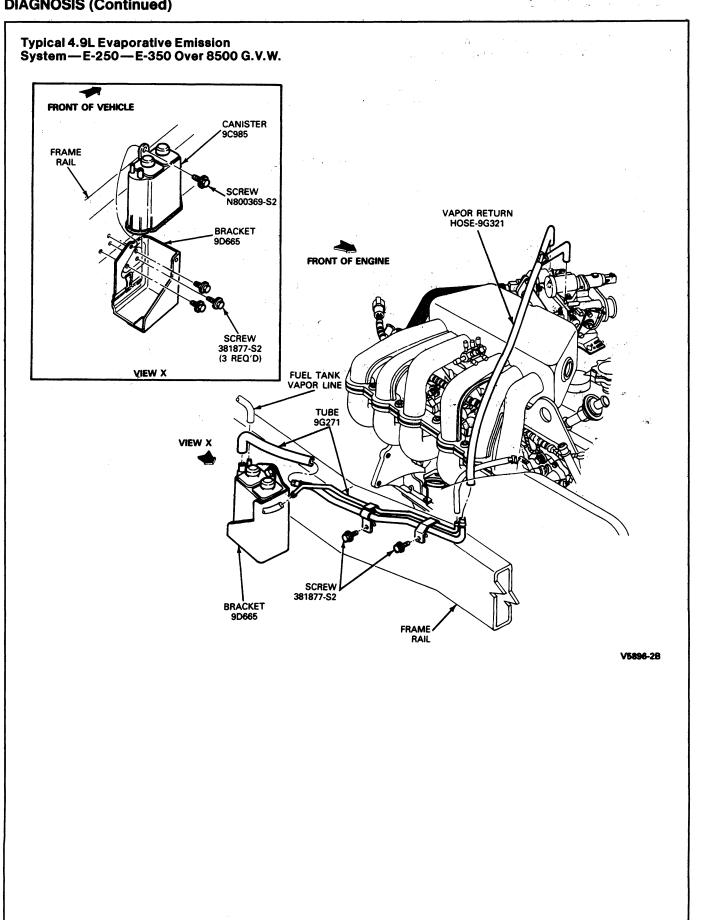
## **Emission System**

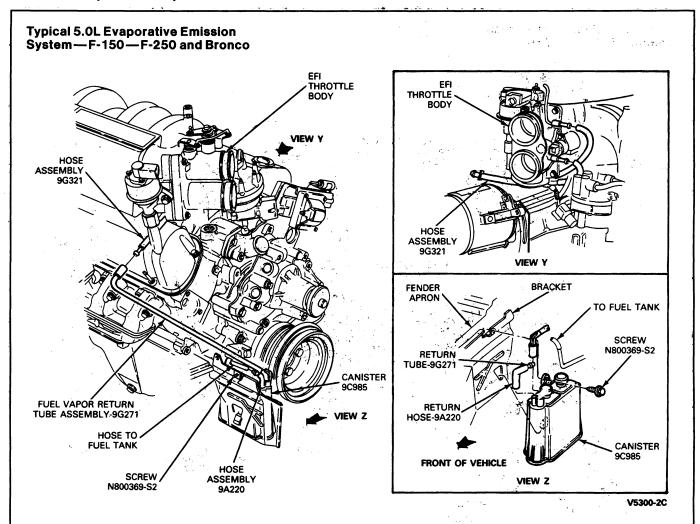
Physical damage, leaks, and missing items are the major answers to diagnosis of emission system complaints. Fill cap damage or contamination that renders the pressure-vacuum valve inoperative may result in deformation of the tank. Care should always be exercised to ensure proper fill cap (in working order) is used. Refer to Volume H, Section 3 of the Engine / Emission Diagnosis\* manual for individual components. Typical carbon canister systems are shown in the following illustrations.

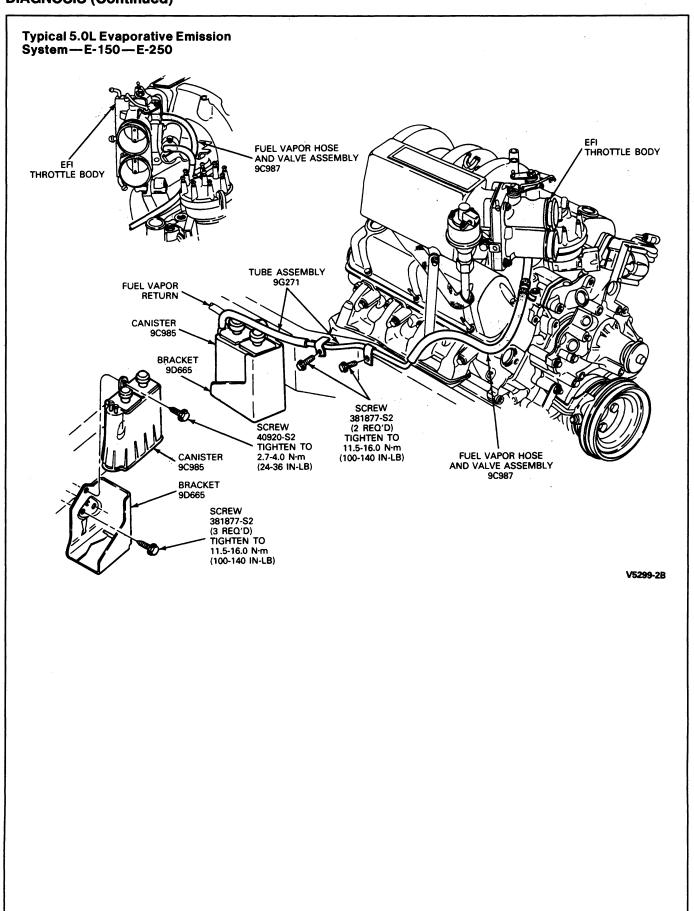


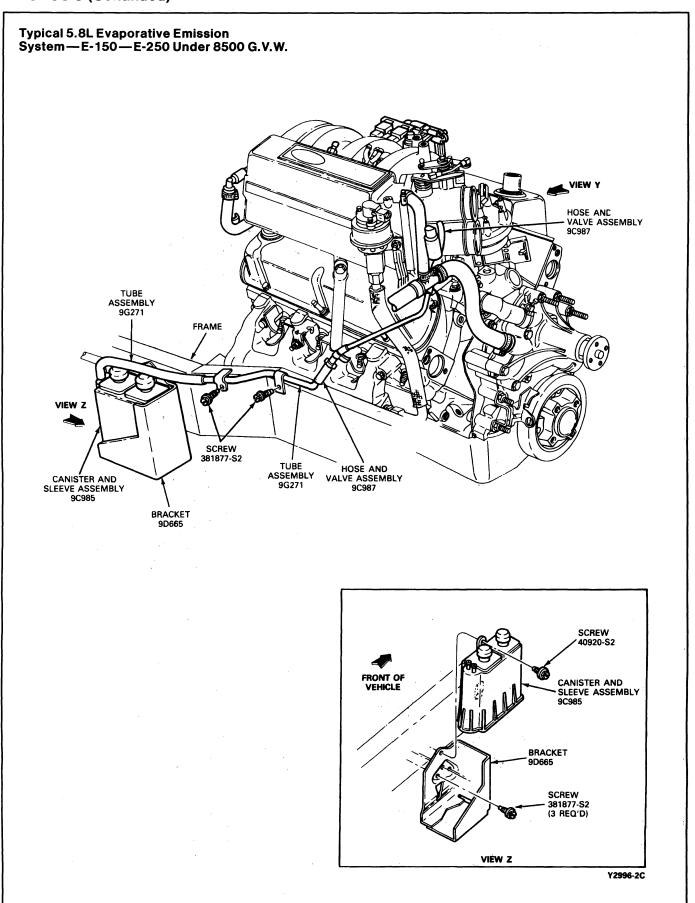
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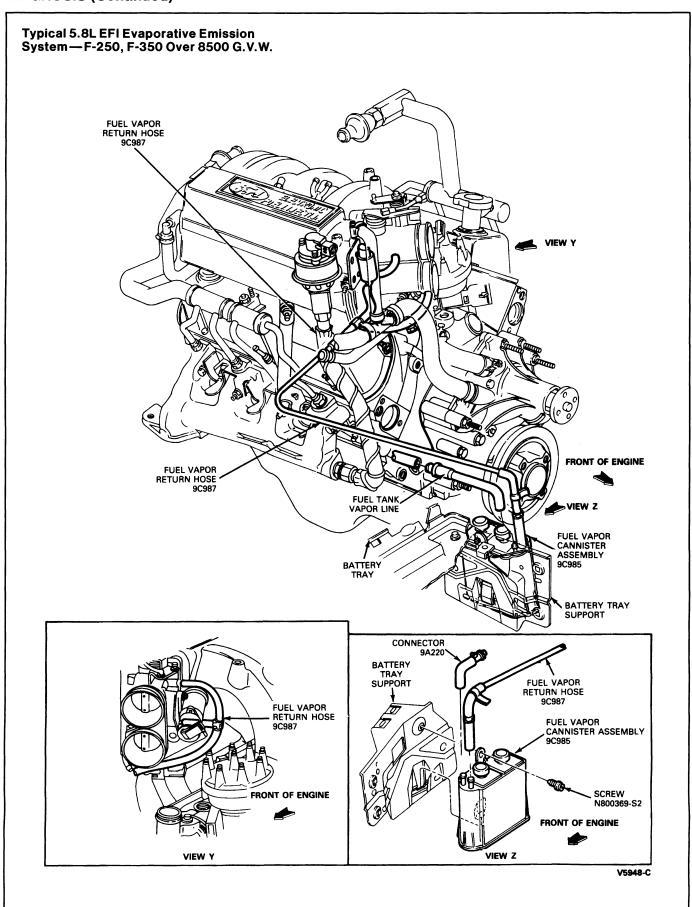




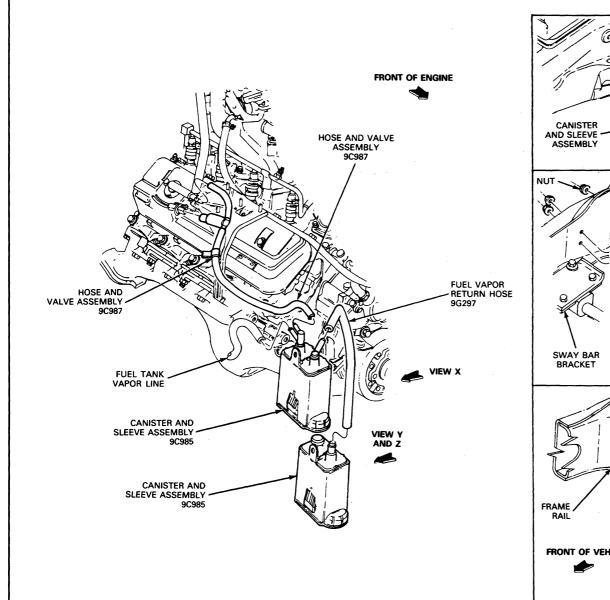


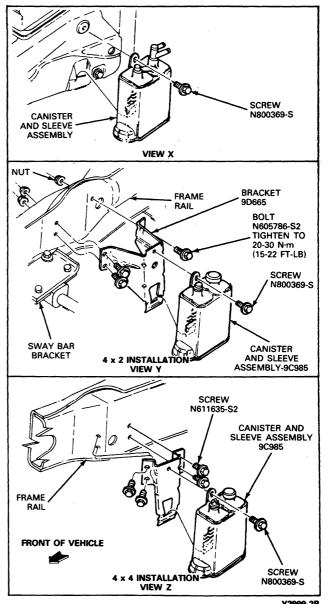


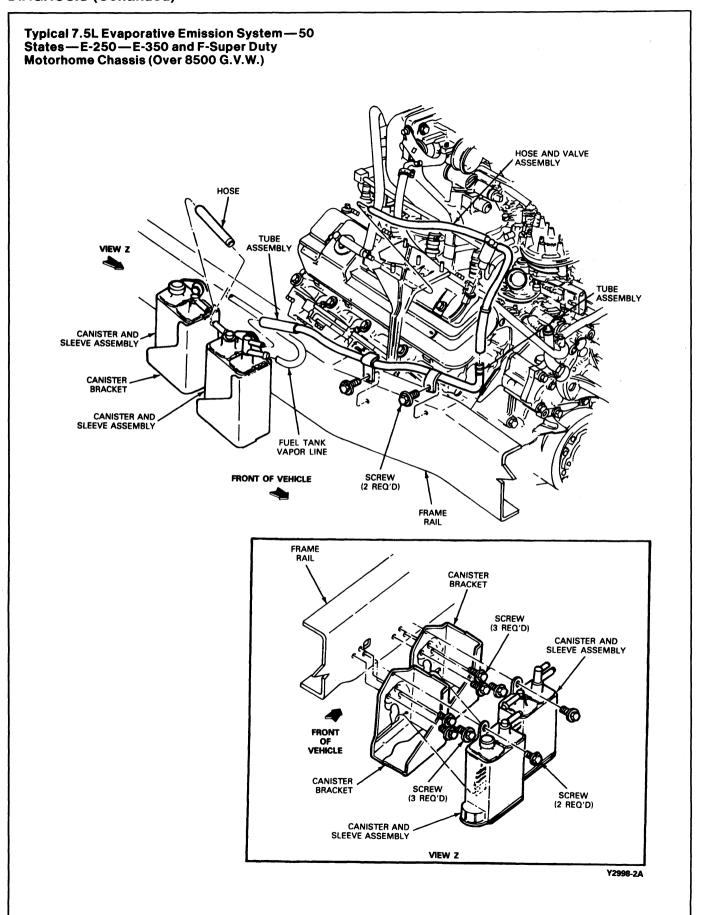




Typical 7.5L Evaporative Emission System—50 States and Canada—F-250, F-350, F-Super Duty (Over 8500 G.V.W)







# Fuel Delivery Module (FDM)—High Pressure: F-Series and Bronco

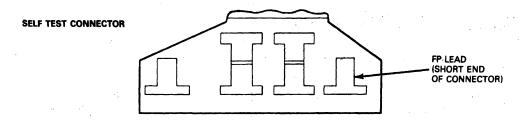
Almost any electric fuel pump malfunction that can occur will result in a reduction of fuel flow and/or pressure. A reduction of fuel flow and/or pressure will be detected by a reduction in engine performance. This diagnostic procedure will concentrate on determining if the electric fuel pump system is operating properly. Other diagnostic procedures will cover the analysis of other malfunctions that can cause losses or reductions of engine performance.

The following diagnostic procedures are to be performed to determine if the electric fuel pump(s) are operating correctly:

NOTE: If no pressure is detected in fuel lines during test procedure, fuel pump should not be powered in excess of three minutes to avoid possible overheating of pump.

#### HIGH PRESSURE PUMP(FDM)DIAGNOSIS GUIDE — 1990 LIGHT TRUCK ENGINES

| Engine Condition  | 4.9L EFI    | 5.0L EFI    | 5.8L EFI    | 7.5L EFI    |
|-------------------|-------------|-------------|-------------|-------------|
| Sacine Burning    | 45-60 PSI   | 30-45 PSI   | 30-45 PSI   | 30-45 PSI   |
| Engine Running    | 310-415 kPa | 210-310 kPa | 210-310 kPa | 210-310 kPa |
| Van ON Faring OFF | 50-60 PSI   | 35-45 PSI   | 35-45 PSI   | 35-45 PSI   |
| Key ON Engine OFF | 345-415 kPa | 210-310 kPa | 210-310 kPa | 210-310 kPa |



CV7917-B

|            | TEST STEP   |     | RESULT   |             | ACTION TO TAKE  |
|------------|---|-----|--|-------------|---|
| <b>B</b> 0 | CHECK STATIC FUEL PRESSURE  |     |  |             |   |
|            | Check for adequate fuel supply.   | Yes |  | •           | GO to B4.   |
|            | • Key off.  | l   |  |             |   |
|            | Install fuel pressure gauge.  | No  |  |             | GO to <b>B1</b> .   |
|            | • Install test lead to FP lead of VIP test connector.   |     | e de la companya de l |             |   |
|            | Turn key to RUN position.   |     |  |             |   |
|            | Ground test lead to run fuel pump.  |     |  |             |   |
| **         | <ul> <li>Refer to Fuel Pressure Specification Table and<br/>check to determine if pressure is within acceptable<br/>limits using Fuel Pressure Gauge, T80L-9974-B or<br/>equivalent, connected to Schrader valve on EFI<br/>fuel rail.</li> </ul> |     |  |             |   |
| B1         | HYDRAULIC CIRCUIT CHECK   |     |  |             |   |
|            | Pressure low but greater than 20.7 kPa (3 psi)     (indicates fuel pump is running but not enough   | Yes | ted⊕.  |             | GO to <b>B2</b> .   |
|            | pressure).  | No  |  |             | GO to <b>B3</b> .   |
| 32         | HYDRAULIC CIRCUIT CHECK   |     |  |             |   |
|            | Plugged fuel line filter (replace filter and check again for proper pressure).  | Yes |  |             | If service was required and made,                                 |
|            | • Kinked/restricted fuel lines (visual inspection).   |     |  |             | GO to B0.   |
|            | <ul> <li>Low voltage to fuel pump (should be within 0.5 volts<br/>of battery voltage at connector).</li> </ul>  | No  |  | <b>&gt;</b> | If no service was required, replace                               |
|            | <ul> <li>Disconnect return fuel line and note if fuel is being<br/>returned during this low pressure condition. If fuel is<br/>being returned, replace or adjust pressure regulator.</li> </ul>   |     |  |             | complete FDM unit and GO to Step B0.                              |
| <b>B3</b>  | ELECTRICAL CIRCUIT CHECK  |     |  |             |   |
|            | • Inertia switch open? (reset switch as required)   | Yes |  |             | SERVICE all electrical  |
|            | Wiring at fuel pump/tank connector loose or open?   |     |  |             | problems and RETURN   |
|            | Fuel pump ground connection at chassis loose or defective?  | No  |  |             | to Step <b>B0</b> .  If no electrical defects                     |
|            | <ul> <li>Improper fuel pump relay operation (should operate<br/>when FP (test) lead is grounded with ignition key in<br/>RUN position).</li> </ul>  | 110 |  |             | have been found, and<br>pump still won't run,<br>REPLACE pump and |
|            | <ul> <li>EEC relay not operating if Fuel Pump Relay doesn't operate?</li> </ul>   |     |  |             | RETEST per Step <b>B0</b> .                                       |
| B4         | CHECK VALVE TEST  |     |  |             |   |
| -          | Remove ground from test lead and note pressure<br>on gauge. Pressure should remain within 20.7 kPa  | Yes |  |             | GO to <b>B6</b> .   |
|            | (2 psi) of indicated value (Key On, engine Off) for 3 minutes after lead is ungrounded.   | No  |  |             | GO to <b>B5</b> .   |

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| * -        | TEST STEP  | RESULT   | ACTION TO TAKE  |
|------------|--|--|---|
| <b>B</b> 5 | CIRCUIT LEAK CHECK   | The second secon |   |
|            | • Fuel lines or connectors leaking?  | Yes  | If service was made GO to Step B0.  |
|            | Disconnect fuel return line and plug engine side.     Momentarily activate fuel pump by grounding test                     | tak mengeberg  | to Step Bu.   |
|            | lead. Raise pressure to approximate operating pressure. Repeat Step <b>B4</b> . If pressure holds,                         | No   | If presure decays rapidly GO to Step B5a. If unit   |
|            | replace regulator and repeat Test B4.  |  | still fails Step <b>B4</b> , there may be a leaking fuel  |
|            |  | e e e e e e e e e e e e e e e e e e e  | injector or rall. CORRECT these problems and GO to  |
| B5a        | CHECK VALVE TEST (FDM)   |  | Step B4.  |
|            | Pressure does not hold?  | Yes  | If equipped with single   |
|            | Pressure decays rapidly enough that needle movement can be observed.   |  | tank, replace FDM unit. If equipped with dual tanks GO to B5b.  |
|            | etro   | no 8   | GO to <b>B6</b> .   |
| 35b        | CHECK VALVE TEST (FDM)   |  |   |
|            | Re-connect fuel supply line to the filter.   | Yes  | Requires further testing.   |
|            | Remove fuel supply line from sender port of<br>midship tank.   | March 1  | GO to B5C.  |
|            | <ol> <li>Change pressure gauge from 5/16" to 3/8" adaptor<br/>to fit fuel line quick-connector.</li> </ol>                 | No 4-12-26-54  | REPLACE aft-of-axle FDM unit and GO to B5c.   |
|            | <ol><li>Connect gauge to end of suply line removed from<br/>midship sender.</li></ol>                                      | The Applied Only   | and the grown of the con-<br>constraints  |
|            | <ol><li>Move the tank selector switch to REAR tank position.</li></ol>   | e de ser e e como e  |   |
|            | <ol><li>Turn ignition switch to RUN position and hold until<br/>fuel pump shuts itself off (approx. one second.)</li></ol> | And the second s | to the second second  |
|            | 7. Turn ignition switch OFF.   | and the state of t | in order of the second of the |
|            | 8. Observe pressure gauge?   |  |   |
|            | Does pressure hold steady?   |  |   |

CV7919-B

|     | TEST STEP   |           | RESULT |             | <b>ACTION TO TAKE</b>  |
|-----|---|-----------|--------|-------------|--|
| 35c | CHECK VALVE TEST (FDM)  |           |        |             |  |
|     | Remove gauge from fuel supply line.     Install 3/8" right-angle quick-connector to pressure  | Yes       |        | <b>&gt;</b> | Midship FDM unit is OK<br>Remove test gauge and<br>connect fuel supply line. |
|     | gauge.  3. Connect gauge to midship tank FDM supply port.   |           |        |             | GO to <b>B0</b> .  |
|     | Move the tank selector switch to the FRONT tank position.   | No        |        | <b>•</b>    | REPLACE midship FDM unit and GO to <b>B0</b> .                               |
|     | <ol><li>Turn ignition switch to RUN position and hold until<br/>fuel pump shuts itself off (approx. one second).</li></ol>  |           |        |             |  |
|     | 6. Turn ignition switch OFF.  |           |        |             |  |
|     | 7. Observe presure gauge.   |           |        |             | • • • •  |
|     | Does pressure hold steady?  |           |        |             |  |
| B6  | ENGINE ON TEST  |           |        |             |  |
|     | If engine is EFI (fuel rail injectors), disconnect and plug the vacuum line connected to the pressure regulator.  State engine and must idle. Fuel pressure should. | Yes<br>No |        | <b>^</b>    | GO to <b>B8</b> . GO to <b>B7</b> .  |
|     | <ul> <li>Start engine and run at idle. Fuel pressure should<br/>be as indicated in chart for Key On, Engine Off.</li> </ul>   |           |        |             | • • • • • • • • • • • • • • • • • • •  |
| B7  | IDLE ENGINE REPAIR  |           |        |             |  |
|     | • Fuel filter restricted (replace)?   | Yes       |        |             | If defect has been found and serviced,                                       |
|     | Improper fuel regulator adjustment?   |           |        |             | GO and BO.   |
|     | <ul> <li>Fuel line restricted?</li> <li>Improper voltage to fuel pump (battery voltage at pump connections)?</li> </ul>   | No        |        | •           | If no defect is found,<br>REPLACE fuel pump<br>and GO to <b>B0</b> .         |
| B8  | HIGH SPEED TEST   |           |        |             |  |
|     | With engine running at idle and vacuum line<br>disconnected if necessary from Step B6, note fuel<br>rail pressure.  | Yes       |        | •           | Fuel pump is OK. If problem persists, CONSULT other parts of                 |
|     | <ul> <li>Rapidly accelerate engine and watch fuel pressure.</li> <li>Does pressure remain within 5 psi of starting pressure?</li> </ul>                             |           |        |             | the manual. DISCONNECT test connections and RECONNECT vacuum                 |
|     | NOTE: Road testing vehicle while monitoring pressure may give a better test under load conditions.  |           |        |             | lead if removed for test.  |
|     |   | No        |        |             | GO to <b>B7</b> .  |

# **EFI Fuel System Pressure and Flow Test Equipment**

Use Adapter D85L-9974-B and Fuel Pressure Gauge T80L-9974-B or equivalent to test the EFI Fuel System electric fuel pump.

#### **Dual Function Reservoir (Dual Tank): Econoline**

The fuel tank selector valve on some vehicles is located in the fuel filter / reservoir mounted on the frame rail. This selector valve differs from previous units by not being electrically activated. The valve is operated by fuel pressure from the in-tank fuel pumps.

When the tank selector switch is in the FRONT position, power from the fuel pump relay is directed to the front tank fuel pump. When the tank selector switch is moved to the REAR position power from the fuel pump relay is directed to the rear tank fuel pump. Pressurized fuel from the fuel pump moves a diaphragm in the dual function reservoir which is connected to a sliding valve. The sliding valve allows fuel to be drawn from and returned to the correct fuel tank. This design relies on proper operation of the tank mounted low-pressure fuel pumps. A functional diagram and procedure for this reservoir is included.

#### **DUAL FUNCTION RESERVOIR DIAGNOSIS GUIDE**

The dual function reservoir is not serviceable. The reservoir requires approximately 13.8 kPa (2.0 psi) of pressure from the in-tank pumps to operate properly.

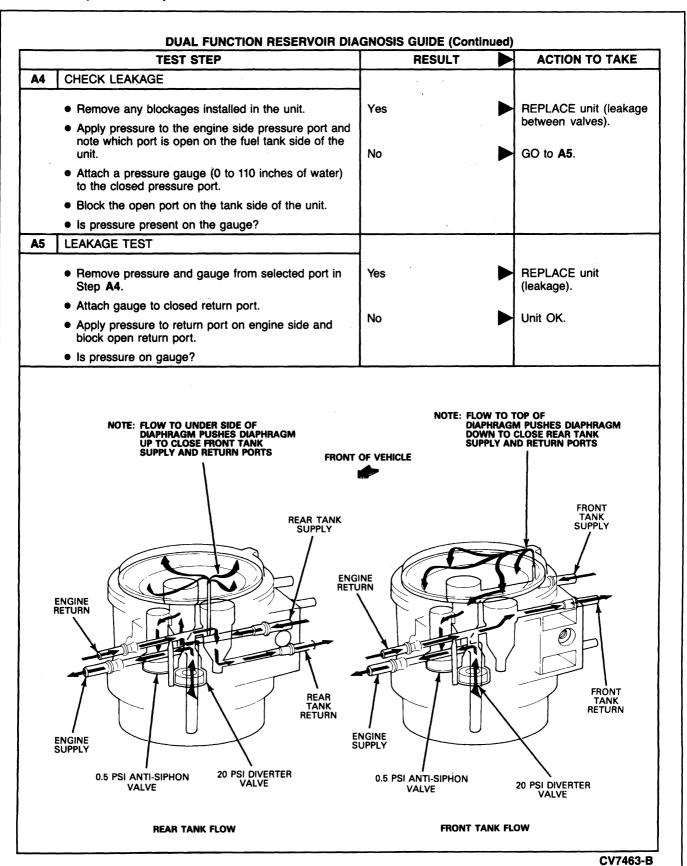
The following procedure should be followed to check the dual function reservoir for proper function:

#### NOTE:

- 1. For the following tests, it is recommended that appropriate sized quick connect fittings be used to connect to reservoir fittings. Damage to the port fittings may result if incorrect fittings are used.
- Regulated air between 20.7-34.5 kPa (3 and 5 psi) should be used for testing. Pressure greater than 5 psi will rupture the internal diaphragm.
- 3. All brackets and fuel lines removed during testing must be secured as originally found after testing is completed.
- 4. The reservoir will contain fuel, care should be taken to prevent spillage or combustion.

| L  | TEST STEP  | RESULT |             | ACTION TO TAKE   |
|----|--|--------|-------------|--|
| A0 | INITIAL CHECK  |        |             |  |
|    | <ul> <li>Remove lines from reservoir - note position and<br/>routing of lines, avoid fuel spillage.</li> </ul>   | Yes    | <b>&gt;</b> | GO to <b>A2</b> .  |
|    | <ul> <li>Apply 20.7-34.5 kPa (3 to 5 psi) air to return port<br/>(small diameter tube) on engine side of reservoir<br/>(only one set of 2 ports).</li> </ul> | No     |             | GO to <b>A1</b> .  |
|    | • Is air out of only one port on other side of reservoir?  |        |             |  |
| A1 | RESET VALVE  |        |             |  |
|    | Block pressure port (large diameter tube) on engine side of unit.  | Yes    |             | GO to <b>A2</b> .  |
|    | <ul> <li>Apply 20.7-34.5 kPa (3 to 5 psi) to either of the<br/>pressure ports on the fuel tank side of the unit.</li> </ul>                                  | No     |             | REPLACE unit (valves stuck).   |
|    | <ul> <li>Remove air and apply to return tube on engine side<br/>of reservoir as in Step A0.</li> </ul>   |        |             |  |
|    | <ul><li>Is pressure out of only one return port on the other<br/>side of the unit?</li></ul>   |        |             |  |
| A2 | CHECK SWITCHING ACTION   |        |             |  |
|    | Block engine pressure port of unit.  | Yes    |             | GO to <b>A3</b> .  |
|    | <ul> <li>Apply 20.7-34.5 kPa (3 to 5 psi) air to one pressure<br/>port and the corresponding return port on the fuel<br/>tank side of the unit.</li> </ul>   | No     | <b>•</b>    | Change to opposite return port and RETEST  |
|    | <ul> <li>Is air pressure out or return port on engine side of<br/>unit?</li> </ul>   |        |             | per <b>A2</b> . If unit fails,<br>REPLACE  |
| АЗ | VALVE SWITCHING  |        |             |  |
|    | <ul> <li>Remove air from pressure port tested previously<br/>and apply air to other set of ports on unit.</li> </ul>   | Yes    | <b>•</b>    | GO to <b>A4</b> .  |
|    | Is air pressure out of return port on engine side?   | No     |             | CHECK connection to return port, if port correct then REPLACE unit (valves stuck). |

CV7462-2A



# **Electric Fuel Pump**

Almost any electric fuel pump malfunction that can occur will result in a reduction of fuel flow and/or pressure. A reduction of fuel flow and/or pressure will be detected by a reduction in engine performance. This diagnostic procedure will concentrate on determining if the electric fuel pump system is operating properly. Other diagnostic procedures will cover the analysis of other malfunctions that can cause losses or reductions of engine performance.

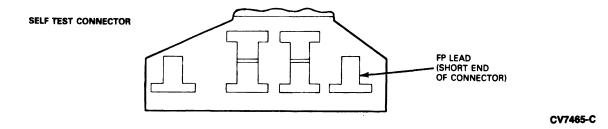
The following diagnostic procedures are to be performed to determine if the electric fuel pumps are operating correctly:

NOTE: If no pressure is detected in fuel lines during test procedure, fuel pump should not be powered in excess of three minutes to avoid possible overheating of pump.

A separate procedure is included to test low-pressure electric fuel pumps. It is only necessary to test low-pressure pumps if noise or very low flow is a problem with two-pump systems.

#### HIGH PRESSURE PUMP(FDM) DIAGNOSIS GUIDE — 1990 LIGHT TRUCK ENGINES

| Engine Condition                                    | 4.9L EFI    | 5.0L EFI    | 5.8L EFI    | 7.5L EFI    |
|---|-------------|-------------|-------------|-------------|
| Engine Dunning                                      | 45-60 PSI   | 30-45 PSI   | 30-45 PSI   | 30-45 PSI   |
| Engine Running                                      | 310-415 kPa | 210-310 kPa | 210-310 kPa | 210-310 kPa |
| Engine Condition  Engine Running  Key ON Engine OFF | 50-60 PSI   | 35-45 PSI   | 35-45 PSI   | 35-45 PSI   |
|   | 345-415 kPa | 210-310 kPa | 210-310 kPa | 210-310 kPa |



|     | TEST STEP   |     | RESULT                                  | ACTION TO TAKE   |
|-----|---|-----|---|--|
| B0  | CHECK STATIC FUEL PRESSURE  |     |   |  |
|     | Check for adequate fuel supply.   | Yes | e F                                     | GO to <b>B4</b> .  |
|     | Key off.  |     | e.                                      | GO 10 <b>D</b> 4.  |
|     | Install Fuel Pressure Gauge T80L-9974-B or equivalent on Schrader valve on fuel rail.   | No  | •                                       | GO to <b>B1</b> .  |
|     | Install test lead to FP lead of VIP test connector.   |     |   | ١.   |
|     | Turn key to RUN position.   | j   |   | •  |
|     | Ground test lead to run fuel pump.  |     |   |  |
|     | <ul> <li>Refer to Fuel Pressure Specification Table<br/>and check to determine if pressure is within<br/>acceptable limits.</li> </ul>  | ž.  |   |  |
| 31  | HYDRAULIC CIRCUIT CHECK   |     |   |  |
|     | Pressure low but greater than 20.7 kPa (3 psi)     (indicates fuel pump is running but not enough pressure).  | Yes | ** *** *** *** *** *** *** *** *** ***  | GO to <b>B2</b> .  |
|     | ,   | No  |   | GO to B3.  |
| 32  | HYDRAULIC CIRCUIT CHECK   | ]   |   | e e e e e e e e e e e e e e e e e e e                          |
|     | <ul> <li>Plugged fuel line filter (replace filter and check<br/>again for proper pressure).</li> </ul>  | Yes | , 5°,                                   | If service was required and made,                              |
|     | Check for system leaks.   | 1   |   | GO to <b>B0</b> .  |
|     | <ul> <li>Kinked/restricted fuel lines (visual inspection).</li> </ul>   | No  |   | If no service was  |
|     | <ul> <li>Disconnect return fuel line and note if fuel is being<br/>returned during this low pressure condition. If fuel is<br/>being returned, replace pressure regulator.</li> </ul> |     |   | required, replace fuel pump and GO to Step <b>B0</b> .         |
| 33  | ELECTRICAL CIRCUIT CHECK  |     |   |  |
| . , | <ul><li>Inertia switch open? (reset switch as required)</li><li>Wiring at fuel pump/tank connector loose or open?</li></ul>   | Yes |   | SERVICE all electrical problems and RETURN to Step <b>B0</b> . |
|     | <ul> <li>Fuel pump ground connection at chassis loose or<br/>defective?</li> </ul>  | No  | - 1 · · · · · · · · · · · · · · · · · · | If no electrical defects                                       |
|     | <ul> <li>Low voltage to fuel pump (should be within<br/>0.5 volts of battery voltage at connector).</li> </ul>  |     |   | have been found, and pump still won't run,                     |
|     | <ul> <li>Improper fuel pump relay operation (should operate<br/>when FP (test) lead is grounded with ignition key in<br/>RUN position).</li> </ul>                                    |     |   | REPLACE pump and RETEST per Step <b>B0</b> .                   |
|     | <ul> <li>EEC relay not operating if Fuel Pump Relay doesn't operate?</li> </ul>   |     | · · · · · · · · · · · · · · · · · · ·   |  |
| 14  | CHECK VALVE TEST  |     |   |  |
|     | Remove ground from test lead and note pressure<br>on gauge. Pressure should remain within 20.7 kPa  | Yes |   | GO to <b>B6</b> .  |
|     | (3 psi) of indicated value (key On, engine Off) for 3 minutes after lead is ungrounded.   | No  |   | GO to <b>B5</b> .  |

CV7466-C

|            | TEST STEP   | RESULT | Ĭ           | ACTION TO TAKE   |
|------------|---|--------|-------------|--|
| <b>B</b> 5 | CIRCUIT LEAK CHECK  | . μι   |             | 7  |
|            | <ul><li>Fuel lines or connectors leaking?</li><li>Disconnect fuel return line and plug engine side.</li></ul>   | Yes    |             | If service was made, GO to Step <b>B0</b> .  |
|            | Momentarily activate fuel pump by grounding test lead. Raise pressure to approximate operating pressure. Repeat Step <b>B4</b> . If pressure holds, replace regulator and repeat Test <b>B4</b> . | No "   | e.i.        | If no problems were found, REPLACE fuel pump and GO to Step B0. If unit still fails Step B4, there may be a feaking fuel injector or rail. CORRECT these problems and GO to Step B4. |
| B6         | ENGINE ON TEST  |        |             |  |
|            | <ul> <li>Disconnect and plug the vacuum line connected to<br/>the pressure regulator.</li> </ul>  | Yes    | <b>&gt;</b> | GO to <b>B8</b> .  |
|            | Start engine and run at idle. Fuel pressure should<br>be as indicated in chart for Key On, Engine Off.  | No     |             | GO to <b>B7</b> .  |
| B7         | IDLE ENGINE REPAIR  |        |             | ,  |
|            | <ul><li>Fuel filter restricted (replace)?</li><li>Improper fuel pressure regulator adjustment?</li></ul>  | Yes    |             | If defect has been found and serviced,   |
|            | • Fuel line restricted?   |        | ,           | GO to <b>B0.</b>   |
| :*<br>*    | <ul> <li>Improper voltage to fuel pump (battery voltage at<br/>pump connections)?</li> </ul>  | No     |             | If no defect is found,<br>REPLACE fuel pump<br>and GO to <b>B0</b> .   |
| B8         | HIGH SPEED TEST   |        |             |  |
|            | With engine running at idle and vacuum line<br>disconnected if necessary from Step B6, note fuel<br>rail pressure.  | Yes    |             | Fuel pump is OK. If problem persists, CONSULT other parts of   |
|            | <ul> <li>Rapidly accelerate engine and watch fuel pressure.</li> <li>Does pressure remain within 35 kPa (5 psi) of starting pressure?</li> </ul>  |        |             | the manual. DISCONNECT test connections and RECONNECT vacuum   |
|            | NOTE: Road testing vehicle while monitoring pressure may give a better test under load conditions.  |        |             | lead if removed for test.  |
|            |   | No     |             | GO to <b>B7</b> .  |

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#### ELECTRIC FUEL PUMP DIAGNOSIS GUIDE — LOW PRESSURE PUMP

#### NOTE:

- 1. If you have multiple fuel tanks on vehicles, it will be necessary to perform this test on both fuel tanks to assure proper operation of both low pressure fuel pumps.
- It has been observed that if the low pressure pump is running, it is almost certain that it is operating correctly. Therefore, flow testing of the fuel pump is only necessary if there is a good reason to suspect pump damage which would cause the pump to 'run but not pump'.
- 3. All tests should be performed with a fully charged vehicle battery. Fuel pump flow is very susceptible to vehicle voltage.

|    | TEST STEP  | RESULT | ACTION TO TAKE   |
|----|--|--------|--|
| CO | INITIAL SET-UP AND TEST  |        |  |
|    | <ul> <li>Attach test lead to FP lead on VIP test connector<br/>(under "ELECTRIC FUEL PUMP DIAGNOSIS"),<br/>make sure lead is long enough to reach work area<br/>under vehicle.</li> </ul>  | Yes No | GO to C1.  |
|    | ● Turn ignition key to RUN position.   |        |  |
|    | <ul> <li>Raise vehicle on hoist and bring test lead to a<br/>convenient point for grounding.</li> </ul>  |        |  |
|    | <ul> <li>Ground test lead and listen at fuel tank for low-<br/>pressure pump operation (a stethoscope or other<br/>device will help to hear pump). The electrical<br/>connection may be disconnected to the high-<br/>pressure pump to aid in hearing the pump run.</li> </ul> |        | a de   |
|    | • Is pump running?   |        | ₩:;  |
| C1 | FLOW TEST  |        | r. Se  |
|    | <ul> <li>Remove ground from test lead.</li> <li>Disconnect pressure line from pump at reservoir inlet fitting.</li> <li>Obtain a calibrated container of at least one quart capacity.</li> <li>Place fuel line removed from reservoir into container.</li> </ul>               | Yes    | Fuel pump OK. REINSTALL lines and REMOVE test connections.  Momentarily restrict line to provide back pressure to prime pump. If no flow |
|    | <ul> <li>Ground test lead and run pump for 5 seconds.</li> <li>Is fuel level at least 6 ounces (180 ml)?</li> </ul>  |        | develops, CHECK for<br>blocked lines and<br>REPLACE pump if no<br>problem found.   |
| C2 | ELECTRICAL CHECK   |        |  |
|    | <ul> <li>If high-pressure pump is not running, check inertia<br/>switch, test connections, fuel pump relay, and any<br/>other wiring problems which could prevent the<br/>pumps from activating. Both pumps run from the<br/>same electrical circuit.</li> </ul>               | Yes    | SERVICE problems found and REPEAT Step C0.  REPLACE pump.  |
|    | <ul> <li>If high-pressure pump runs, check connections at<br/>top of fuel tank to pump for continuity and for<br/>voltage when circuit is energized.</li> </ul>  | pro-   |  |
|    | Was electrical problem found?  | ***    |  |

CV7468-C

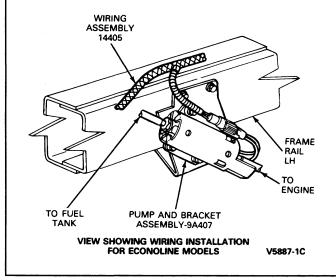
# **EFI Fuel System Pressure and Flow Test Equipment**

Use Adapter D85L-9974-B and Fuel Pressure Gauge T80L-9974-B or equivalent to test the EFI Fuel System electric fuel pump.

# High-Pressure Pump—Econoline 4.9L, 5.0L, 5.8L and 7.5L EFI Engines

#### Replacement

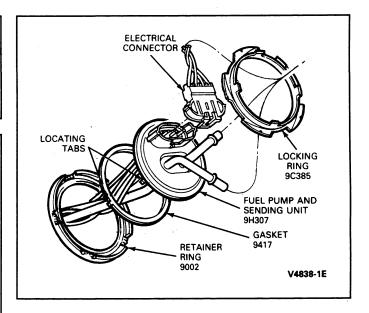
The high-pressure fuel pump is frame mounted and can be accessed from under the vehicle. Before removing the fuel pump, relieve the pressure in the fuel system using Fuel Pressure Gauge T80L-9974-B or equivalent on the feeler diagnostic valve, or by opening the electrical circuit to the fuel pump and cranking the vehicle for a minimum of 20 seconds. Refer to the procedures outlined in this section, for Fuel System Pressure Relief, and Push Connect Fitting procedures.



# Low-Pressure Pump—Econoline 4.9L, 5.0L, 5.8L and 7.5L EFI Engines

#### Replacement

The low-pressure pump is located in the fuel tank and may require removal of the fuel tank for replacement. Refer to the procedures outlined in this section for fuel tank removal and installation. Refer to Section 13-03, Fuel Gauge, for fuel pump-sender assembly removal and installation procedure (same as for sender only).



#### **Inertia Switch**

In the event of a collision, the electrical contacts in the inertia switch open and the fuel pump automatically shuts off. The fuel pump will shut off even if the engine does not stop running. The engine, however, will stop a few seconds after the fuel pump stops. It is not possible to restart the engine until the inertia switch is manually reset.

CAUTION: Do not reset the inertia switch until the complete fuel system has been inspected for leaks.

To reset the inertia switch, depress the button on top of the switch.

#### **Switch Location**

On F-Series the switch is on the far left part of the toe-board, near the parking brake assembly.

On E-Series the switch is on the passenger side cowl panel, just forward of the right front door.

WARNING: IF YOU SEE OR SMELL GASOLINE AT ANY TIME OTHER THAN DURING FUELING, DO NOT RESET THE SWITCH.

# REMOVAL AND INSTALLATION

#### **Fuel System Pressure Relief**

#### **EFI Engines**

CAUTION: Fuel supply lines on 4.9L EFI, 5.0L EFI, 5.8L EFI, and 7.5L EFI engines will remain pressurized for some period of time after the engine is shut off. This pressure must be relieved before servicing of the fuel system.

Before opening the fuel system on vehicles with EFI engines, relieve fuel pressure as follows:

 Locate and disconnect the electrical connection to either the fuel pump relay, the inertia switch or the in-line high pressure fuel pump.

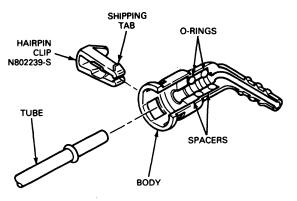
- Crank engine for approximately ten seconds.
   Note: Engine may start and run for a short time. If
   so, crank engine an additional five seconds after
   engine stalls.
- Connect the electrical connector that was disconnected in step 1.
- Disconnect battery ground cable.

#### **Fuel Lines and Hoses**

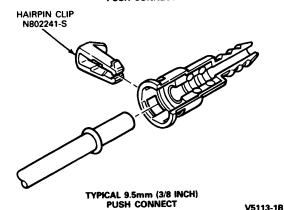
CAUTION: Fuel supply lines on vehicles with fuel injected engines will remain pressurized for long periods of time after engine shut-down. The pressure must be relieved, as outlined, before servicing the fuel system.

#### **Push Connect Fittings**

Push connect fittings are designed with two different retaining clips. The fittings used to connect to 9.5mm (3/8-inch) and 7.9mm (5/16-inch) nominal diameter tubing use a "hairpin" clip. The fittings used with 6.3mm (1/4-inch) nominal diameter tubing uses a "duck bill" clip. Each type of fitting requires different procedures for service. Clips should be replaced whenever a connector is removed.



TYPICAL 7.9mm (5/16 INCH)
PUSH CONNECT



The fuel lines connecting to the EFI engine fuel rails are a special, spring-lock, metal design. The fuel feed line uses a 12.7mm (1/2-inch) spring lock connector. The fuel return uses a 9.5mm (3/8-inch) spring lock connector.

# 7.9mm (5/16-Inch) or 9.5mm (3/8-Inch) Fittings (Hairpin Clip)

#### Removal

- Inspect visible internal portion of fitting for dirt accumulation. If more than a light coating of dust is present, clean the fitting before disassembly.
- Some adhesion between the seals in the fitting and the tubing will occur with time. To separate, twist the fitting on the tube, then push and pull the fitting until it moves freely on the tube.
- 3. Remove "hairpin" type clip from fitting by first bending the shipping tab downward so that it will clear the body. Next (using hands only), spread the two clip legs approximately 3mm (1/8 inch) each to disengage the body and push the legs into the fitting. Complete removal is accomplished by lightly pulling from the triangular end of the clip and working it clear of the tube and fitting.

#### CAUTION: Do not use any tools.

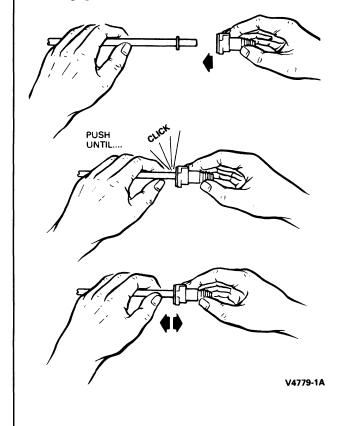
- 4. Grasp the fitting and hose assembly and pull in an axial direction to remove the fitting from the tube.
- 5. When fitting is removed from the tube end, inspect the fitting and tube for any internal parts that may have been dislodged from the fitting. Any loose internal parts should be immediately reinstalled, using the mating tube to insert the parts.

Disconnect all push connect fittings from components (pump, filter, engine) prior to component removal. The push connect fittings to connect flexible fuel lines to the fuel tank sender often cannot be disconnected until the tank is partially lowered just before removing the fuel tank completely.

#### Installation

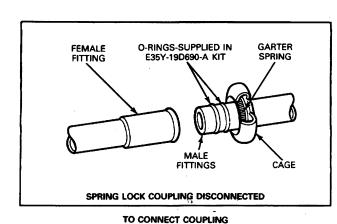
- It is recommended that the original clip **not** be reused in the fitting. To install the new clip, insert clip into any two adjacent openings with the triangular portion pointing away from the fitting opening. Install clip to fully engage the body (legs of "hairpin" clip locked on outside of body). Piloting with an index finger is necessary.
- 2. Before installing fitting on the tube, wipe tube end with a clean cloth. Inspect the inside of the fitting to ensure it is free of dirt and / or obstructions.

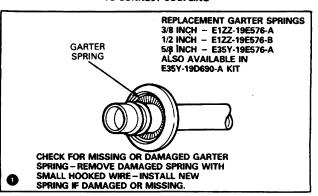
 To install the fitting onto the tube, align the fitting and tube axially and push the fitting onto the tube end. When the fitting is engaged, a definite click will be heard. Pull on fitting to ensure it is fully engaged.

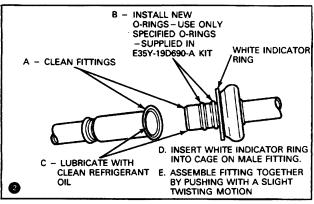


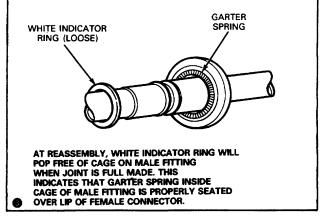
# Metal Spring-Lock Connectors (4.9L EFI, 5.0L EFI, 5.8L EFI and 7.5L EFI Engines)

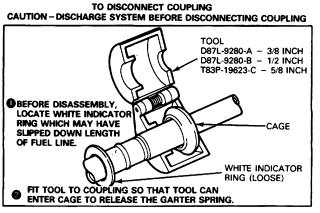
The tools will not always fit over the shielded line. To accommodate the shielding, the hole in the tubing end of the tool must be enlarged. To do this, clamp the tool closed and drill out the existing hole with 5/8-inch bit. Be careful to drill only the tubing hole and not the working end of the hole.

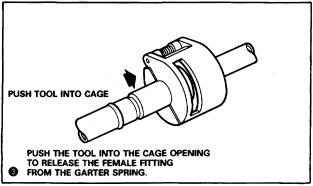


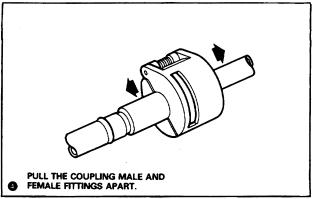


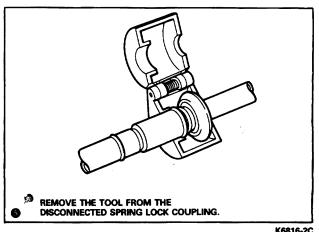










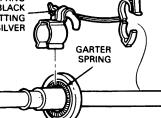


#### **Retainer Installation**

EFI F-SERIES, E-SERIES AND BRONCO FOR 1/2" FITTING N805528-S190- BLACK FOR 3/8" FITTING N805526-S190-SILVER

THE RETAINER IS TO BE INSTALLED BY AN OPERATOR SUBSEQUENT TO THE INITIAL INSTALLATION OF THE SPRING LOCK COUPLING CONNECTION.

1. PULL ON CONNECTOR OPPOSITE TO THE DIRECTION OF INSTALLATION TO VERIFY THAT THE CONNECTOR IS LOCKED IN PLACE.

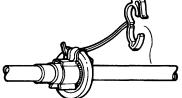


VISUALLY CHECK TO BE SURE GARTER SPRING IS OVER FLARED END OF FEMALE FITTING. AND PULL ON FITTING TO ENSURE FULL ENGAGEMENT

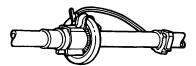
SPRING LOCK COUPLING - FOR FUEL LINE TO ENGINE FUEL RAIL CONNECTIONS

2. INSTALL RETAINER ACCORDING TO THE ILLUSTRATION ON ALL EFI F-SERIES.

THE 1/2" RETAINER (BLACK) IS TO BE INSTALLED ON THE FUEL SUPPLY LINE AND THE 3/8" RETAINER (SILVER) IS TO BE INSTALLED ON THE FUEL RETURN LINE.



3. ATTACH TETHER TO THE FUEL LINE.

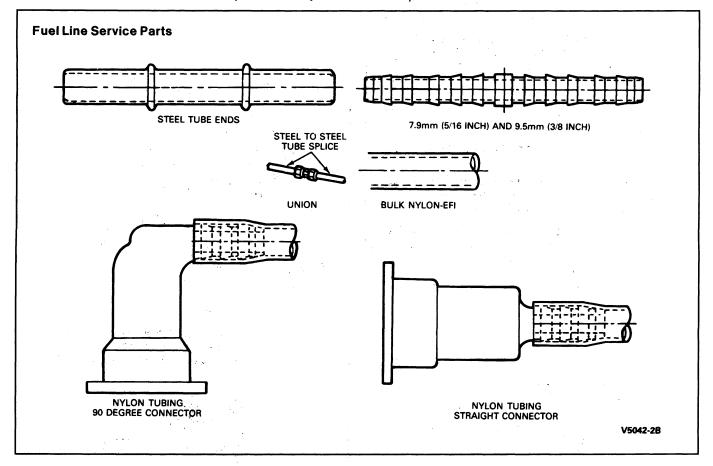


V7472-B

#### Fuel Tubes—Plastic

CAUTION: Ford-approved nylon fuel tubing is made from material which has been tested and proven to be acceptable for use with commercially available fuels. It is also resistant to most environmental conditions. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Plastic fuel tube must not be repaired using hose and hose clamps. Push connect fittings cannot be repaired except to replace the retaining clips. Should the plastic tubes, push connect fittings, or steel tube ends become damaged and leak, approved service parts must be used to service the fuel lines.



The F-Series, Econoline and Bronco vehicles use at least some flexible nylon fuel and fuel return lines. The plastic fuel tube assembly is secured to the body rails with nylon wrap-around clips and push-in clips.

CAUTION: The plastic fuel lines can be damaged by torches, welding sparks, grinding, and other operations which involve heat and high temperatures. If any repair or service operation will be used which involves heat and high temperatures, locate all fuel system components, especially the plastic fuel lines, to be certain they will not be damaged. It is recommended that the plastic fuel tubes be removed from the vehicle if a torch or high heat producing equipment is to be used for service in the following areas:

- Exhaust or suspension components in proximity to fuel tubes.
- Underbody frames, rails and crossmembers (LH side).
- Dash panel; under vehicle or inside the passenger compartment (lower LH side).
- Front or rear wheel house / fender apron (LH side).

#### **Fuel Return System**

A fuel return system is used to maintain fuel flow at the fuel charging assembly.

The fuel return system is serviced in the same manner as the fuel lines.

NOTE: Plastic fuel return tubes must be repaired using the repair procedure for plastic tubes.

NOTE: Torque specifications are included in applicable illustrations.

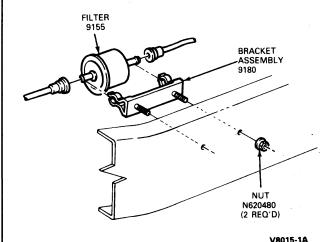
# Fuel Filter—In-Line Type—4.9L HS, 5.0L, 5.8L and 7.5L EFI Engines

#### Removal

CAUTION: If the fuel filter is being serviced with the rear of the vehicle higher than the front, or if the tank is pressurized, fuel leakage or siphoning from the tank fuel lines could occur. To prevent this condition, maintain the vehicle front end at or above the level of the rear of vehicle. Also, relieve tank pressure by loosening the fuel fill cap. Cap should be retightened after pressure is relieved. If vehicle is warm, change the fuel filter before the pressure rebuilds.

- Shut engine off. De-pressurize fuel system. Refer to Fuel System Pressure Relief EFI Engines, in the Removal and Installation portion of this section. Use caution to prevent combustion from fuel spillage.
- Raise vehicle on hoist. Refer to Section 00-02, Hoisting, Jacking and Towing.
- Loosen screw clamp so that filter slides rearward easily.
- Remove push connect fittings at both ends of the filter as outlined in this section. Install new retainer clips in each push connect fitting.
- On E-Series, remove fuel filter from metal bracket by rotating the -9A322- fuel line, being careful not to kink the fuel line, and sliding the filter rearward. On F-Series—Bronco, gently pull filter from bracket, being careful not to kink fuel line.

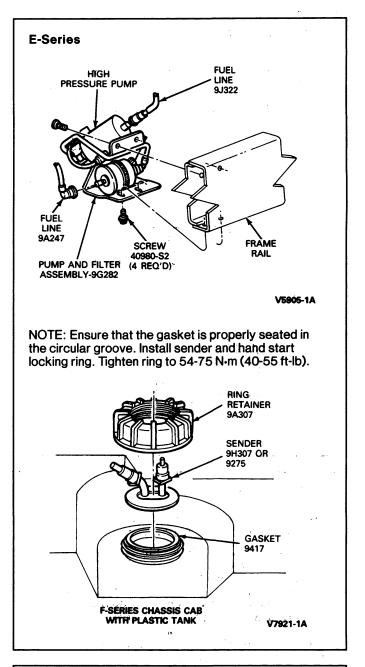
#### F-Series-Bronco



#### Installation

Note that the direction of the flow arrow points to the tab of the bracket against which the filter rests.

- On E-Series, place filter into the bracket with flow arrow pointing toward tab of the bracket. Slide filter forward until it rests against tab of the bracket. On F-Series—Bronco, position filter and push to snap into bracket.
- 2. On E-Series, tighten retaining screw of the screw clamp to 1.8-2.8 N·m (1.3-2.1 ft-lb).
- Install push-connect fittings onto filter ends as outlined in this section.
- Turn ignition switch from OFF to RUN position several times, without starting engine. Check for fuel leaks.
- 5. Lower vehicle.



#### Fuel Reservoir—Econoline

NOTE: The removal of the Econoline transmission crossmember on the 138 inch wheelbase vehicles requires that the fuel reservoir be removed first. If the reservoir is not removed before removal and/or installation of the transmission crossmember, interference will occur and damage to the reservoir may occur. Removal of the reservoir is not required for removal of the E4OD transmission crossmember.

#### Removal

- Disconnect the fuel lines from the fuel reservoir (single or dual function).
- Remove the four bolts which hold the reservoir bracket to the frame.

#### Installation

- Install the fuel reservoir and bracket assembly. Tighten the four attaching bolts to 17-23 N·m (12-17 ft-lb).
- Prepare the push connect fittings on the disconnected fuel lines for installation and install the fuel lines as outlined.

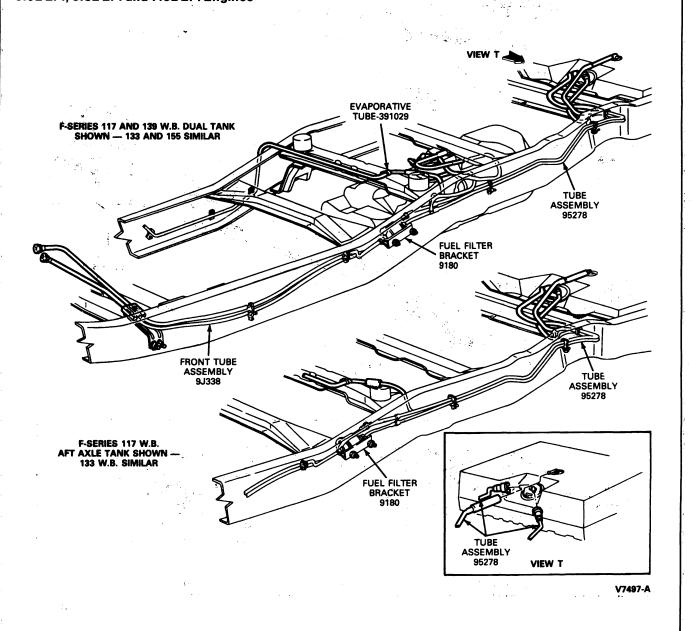
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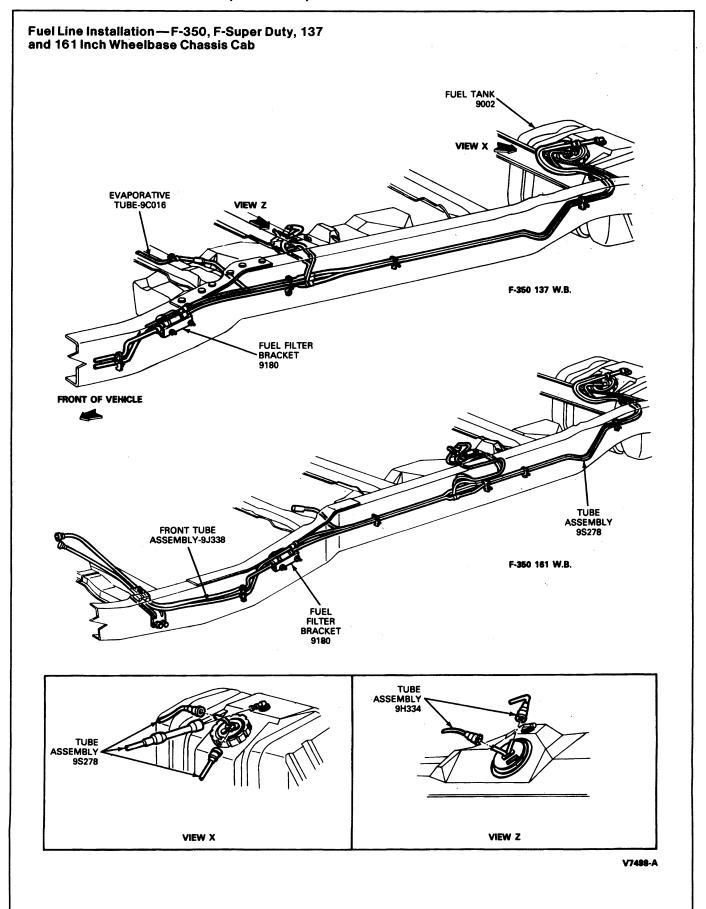
#### **Fuel Tanks**

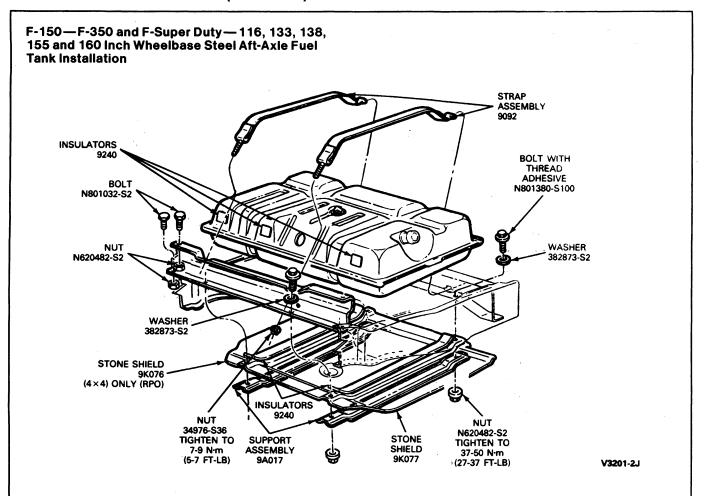
# F-150—F-350, F-Super Duty Chassis Cab and Motorhome Chassis

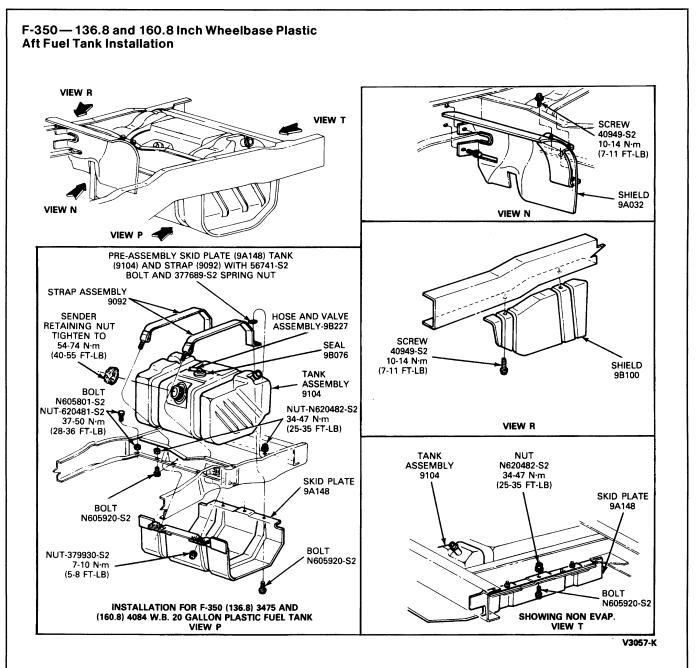
Typical fuel line and tank installations are shown in the following illustrations. Refer to the specifications for the capacities and usage.

Fuel Line Installation—F-150—F-350—4.9L EFI, 5.0L EFI, 5.8L EFI and 7.5L EFI Engines

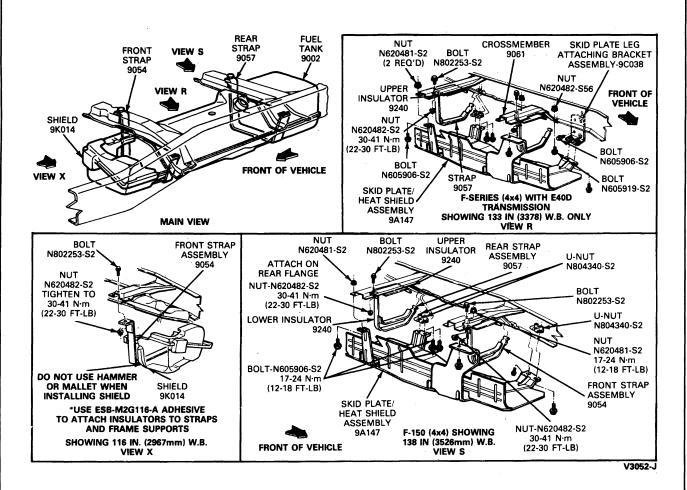


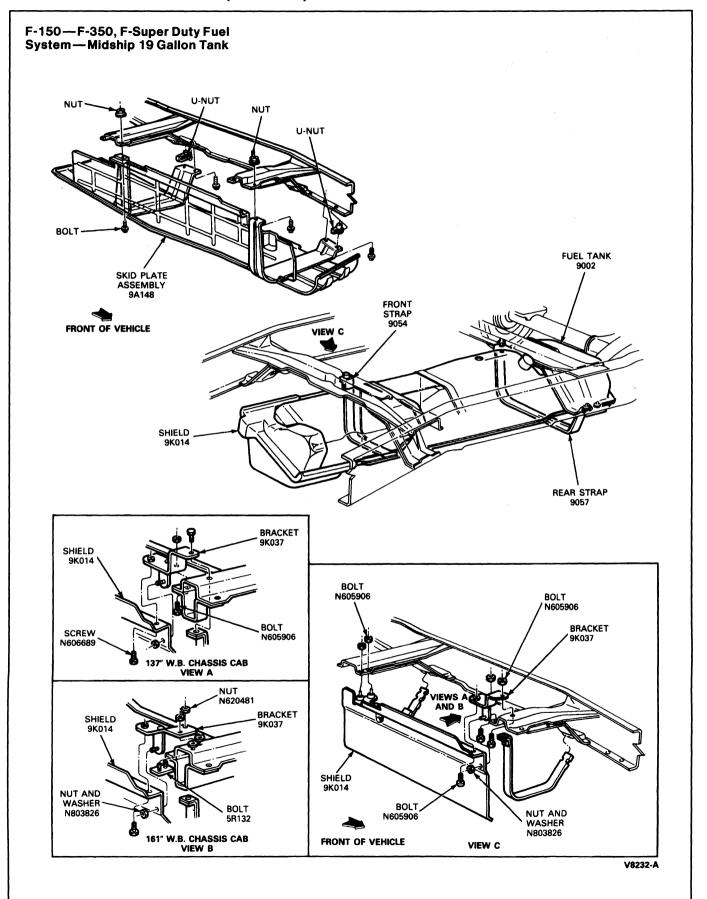


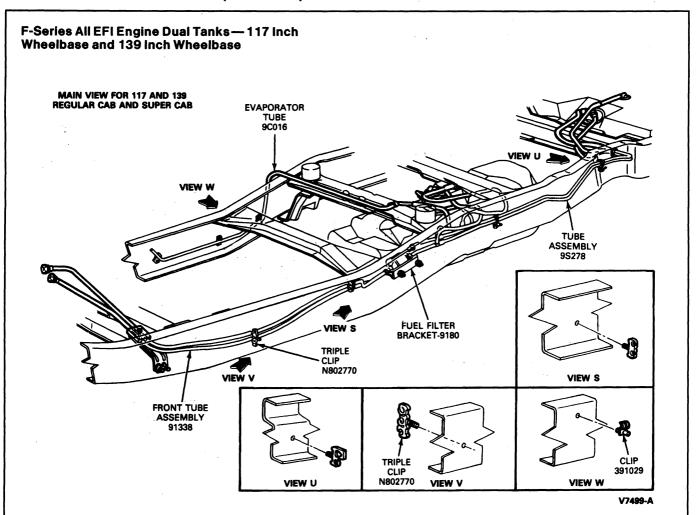


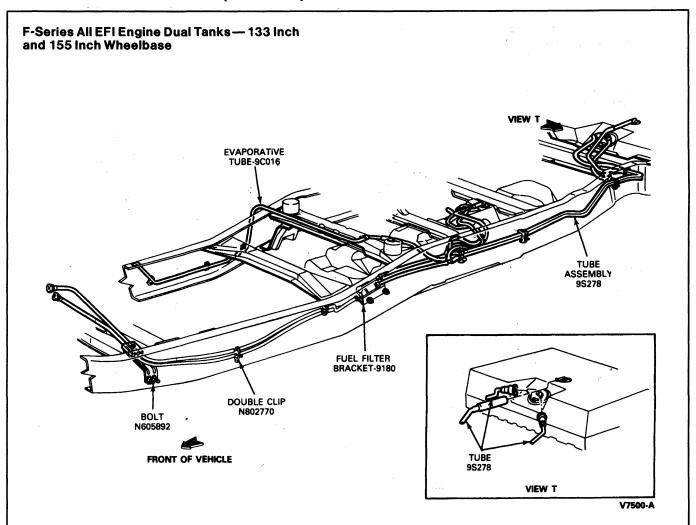


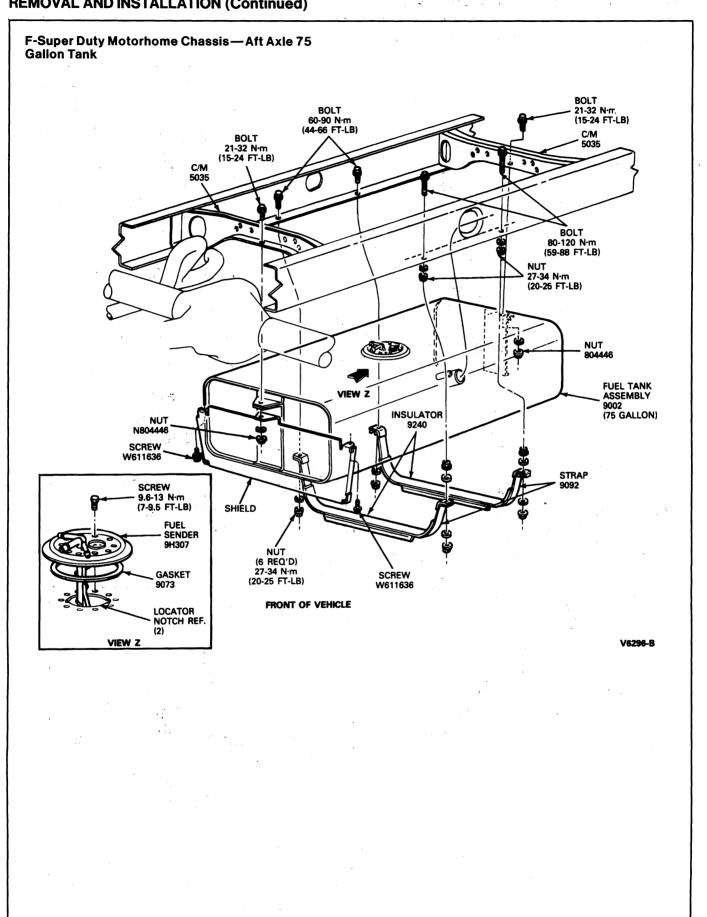
F-150 (4x2)—116 and 138.6 Inch Wheelbase, F-150 (4x4) 138 Inch Wheelbase, and F-250 (4x2) 138.8 Inch Wheelbase Midship 16.5 Gallon Fuel Tank and F-Series (4x4)—133 Inch Wheelbase with E40D Transmission—Installation



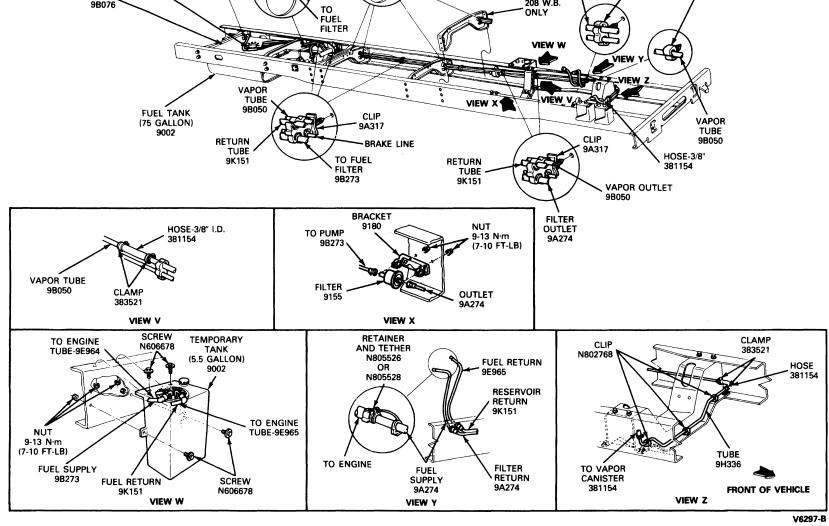








#### REMOVAL F-Super Duty Motorhome Chassis—Fuel Lines RETURN RETURN VAPOR TUBE CLIP **VAPOR** CLIP TUBE 9K151 N802768 TUBE TUBE 9K151 9A317 9B050 9B050 **VAPOR** CLIP AND **VAPOR** VALVE -CLIP-9A317 N802769 TUBE 9B227 -BRAKE LINE 9B050 CLIP **INSTALLATION (Continued)** TO FUEL FILTER N802768 SEAL 208 W.B. 9B076 то ONLY **FUEL** FILTER **VAPOR** TUBE 9B050 FUEL TANK CLIP **VAPOR** (75 GALLON) 9002 9A317 TUBE CLIP 9B050 RETURN BRAKE LINE 9A317 TUBE HOSE-3/8" TO FUEL 9K151 RETURN 381154 **FILTER** TUBE 9B273 9K151 **VAPOR OUTLET**

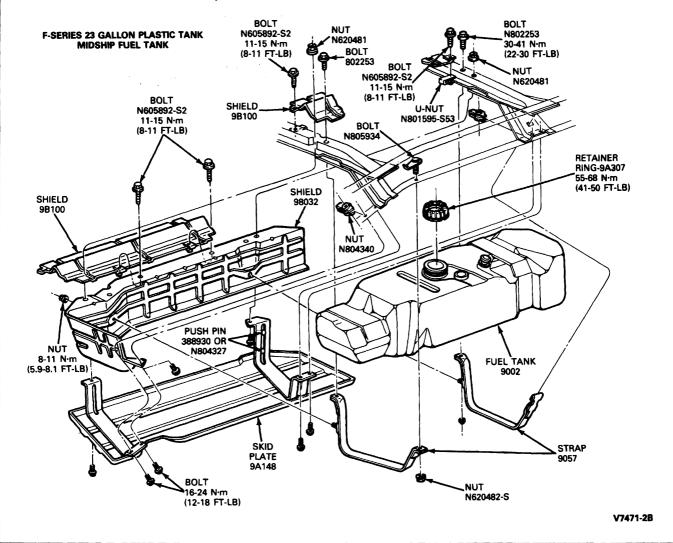


# Midship Fuel Tank—Plastic Removal

- Drain the fuel into a suitable container by siphoning through the fuel hose at the fuel pump-to-fuel tube connection.
- 2. To avoid electrical sparking at the tank, disconnect the ground cables on both batteries.
- 3. Remove skid plate and heat shields.
- Disconnect the fuel gauge sending unit wire at the fuel tank.

- Loosen fuel filler hose clamp at the tank and disconnect the fuel filler hose.
- 6. Disconnect the fuel tube push-connect fittings at fuel gauge sending unit.
- Support the tank. Remove the bolts from the retaining straps and lower the tank to the floor.
- To remove fuel gauge sending unit, rotate threaded retainer ring counterclockwise with TOOL (TBI) or equivalent.
- 9. To remove vapor valve, pull it out of the grommet.
- 10. Replace any worn or damaged parts.

# F-Series 23 Gallon Plastic Midship Fuel Tank



#### Installation

- Position fuel gauge sending unit seal in groove.
  Then, position fuel gauge sending unit in tank and
  install threaded retainer ring with the appropriate
  special service tool or equivalent. Tighten to
  55-68 N·m (41-50 ft-lb).
- 2. Insert vapor valve into grommet.
- Position tank in vehicle and secure retaining straps to frame with hand-started attaching bolts.

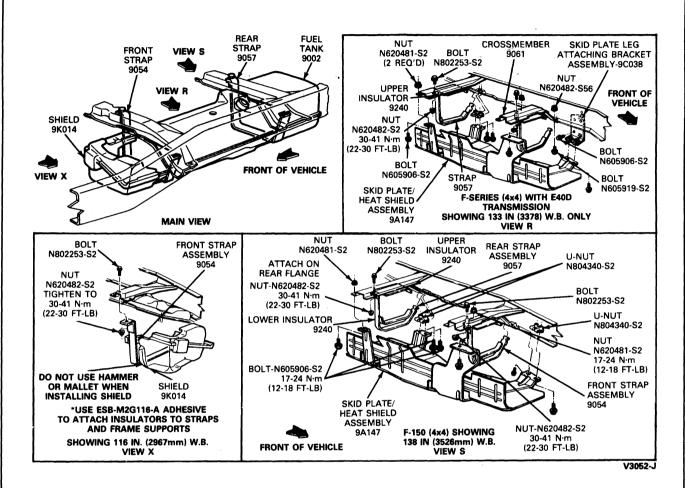
- Position and secure fuel filler hose on fuel tank filler neck. Tighten hose clamp to 3-4 N-m (27-35 in-lb).
- 5. Clip vapor valve hose to frame rail.
- Connect the fuel tubes and electrical connector to the fuel gauge sender unit.
- Tighten strap attaching bolts to 16-24 N·m (12-18 ft-lb).
- Position heat shield on fuel tank retaining strap studs and tighten attaching nuts to 8-11 N-m (6-8 ft-lb).
- Position skid plate in vehicle and secure the skid plate and heat shield to frame with attaching bolts and nuts. Tighten to 8-11 N·m (6-8 ft-lb).
- Position heat shield in vehicle and secure it to the frame and the heat shield with attaching bolts. Tighten to 8-11 N·m (6-8 ft-lb).
- 11. Connect battery ground cables at both batteries.
- 12. Fill the tank and check all connections for leaks.

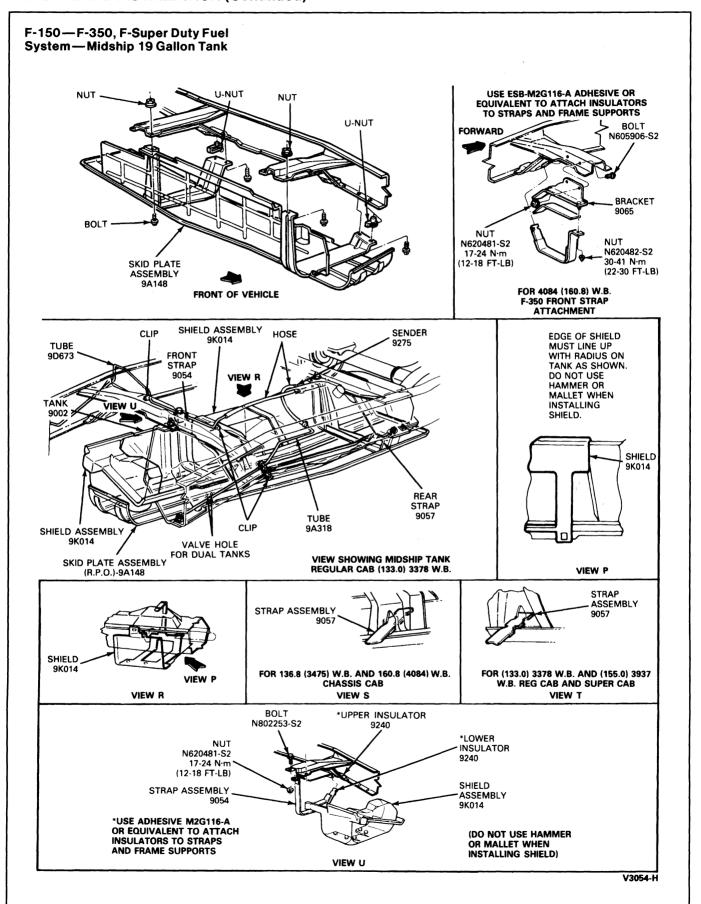
# Midship Fuel Tank Steel

#### Removal

- Drain the fuel into a suitable container by siphoning through the fuel hose at the fuel pump-to-fuel tube connection.
- To avoid electrical sparking at the tank, disconnect battery ground cable. Then disconnect the fuel gauge sending unit wires at the fuel tank.
- 3. On vehicles with dual tanks, disconnect ground wire after draining both tanks. Loosen the clamp and disconnect the hose attached to the fuel tank by pulling along the rubber inner tube from the tank filler neck. On a vehicle equipped with a fuel evaporative emission control system, disconnect the vapor line from the vapor emission control valve.
- 4. Support the tank, remove the nuts and bolts from the retaining straps, and lower tank to floor. Replace any worn or damaged parts.

F-150 (4x2) — 116 and 138.6 Inch Wheelbase, F-150 (4x4) 138 Inch Wheelbase, and F-250 (4x2) 138.8 Inch Wheelbase Midship 16.5 Gallon Fuel Tank and F-Series (4x4) — 133 Inch Wheelbase with E40D Transmission — Installation





#### Installation

- Position retaining straps around fuel tank and attach bolts and nuts. Tighten to 30-41 N·m (22-30 ft-lb).
- Insert the rubber inner hose inside the filler neck and connect the hose to the tank. Tighten the clamps to 3-4 N·m (25-35 in-lb). On a vehicle equipped with a fuel evaporative emission control system, connect the vapor lines to the emission control valve located in the top of the tank.
- Fill tank with fuel, connect the battery ground cable, and start the engine. Check for leaks.

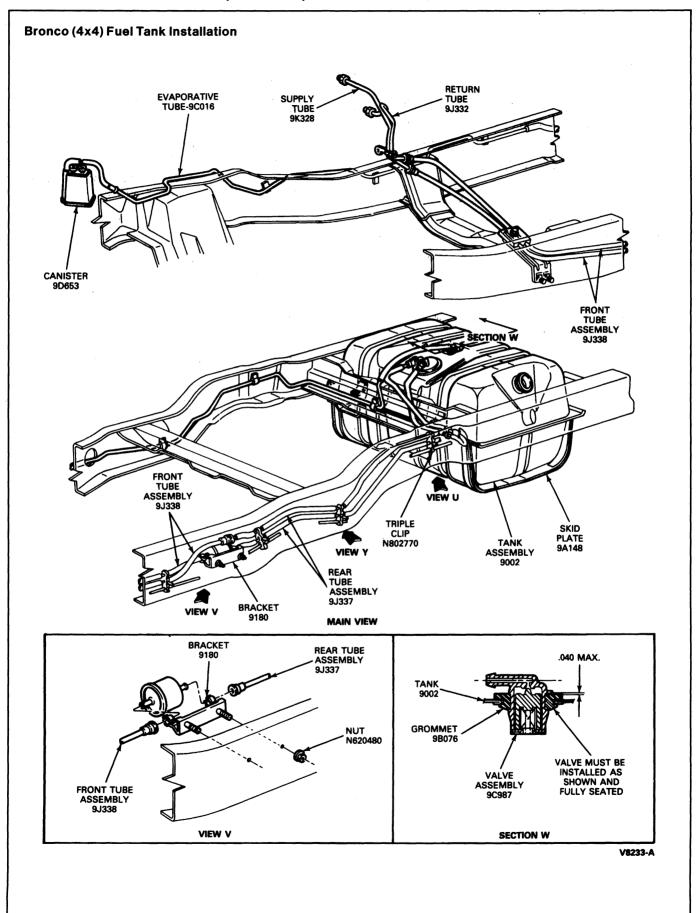
# Aft-Of-Axle Fuel Tank—Bronco and F-Series Removal

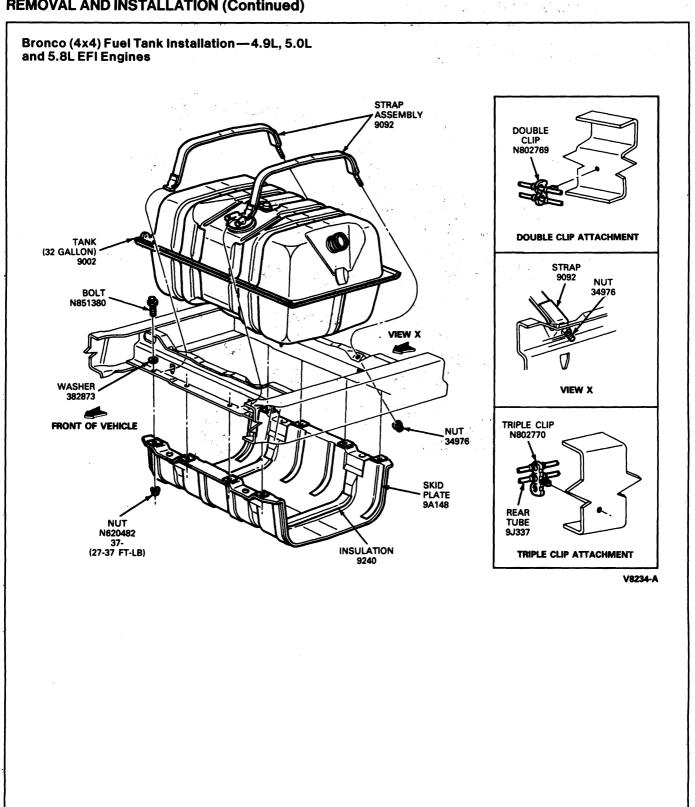
- 1. Raise the rear of the vehicle.
- To avoid electrical sparking at the tank, disconnect battery ground cable. Then disconnect the fuel gauge sending unit wire at the fuel tank.
- On vehicles with dual tanks, disconnect the ground wire after both tanks have been drained. Siphon the fuel from the tank into a suitable container at the hose between the fuel pump and the fuel tube.

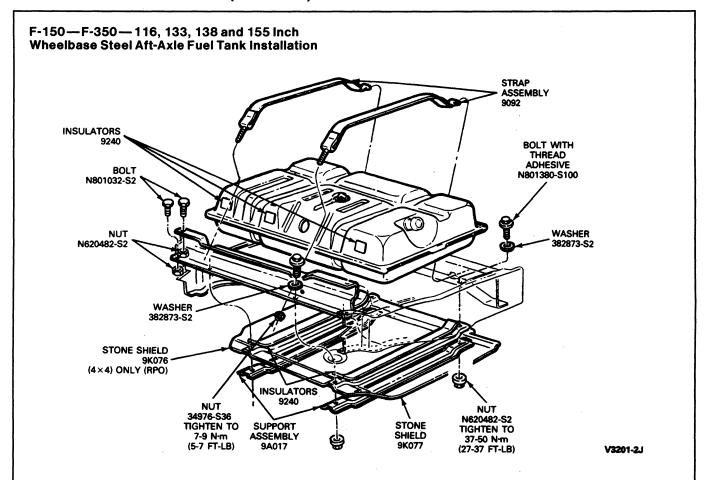
- 4. Disconnect the fuel line push-connect fittings at the fuel gauge sending unit.
- If the fuel gauge sending unit is to be removed, turn the unit retaining ring counterclockwise and remove the sending unit, retaining ring and gasket.
- Loosen the clamp on the fuel filler pipe.
   Disconnect the filler pipe hose by pulling along the rubber inner tube from the tank filler neck.
- 7. If removing the metal-type tank, support the tank and remove the bolts attaching the tank supports to the frame. Carefully lower the tank and disconnect the vent tube(s) from the vapor emission control valve in the top of the tank. Finish removing the filler pipe and filler pipe vent hose if not possible in step 6. Remove the tank from under the vehicle.
- 8. If removing the plastic-type tank, support the tank and remove the bolts attaching the combination skid plate and tank support to the frame.

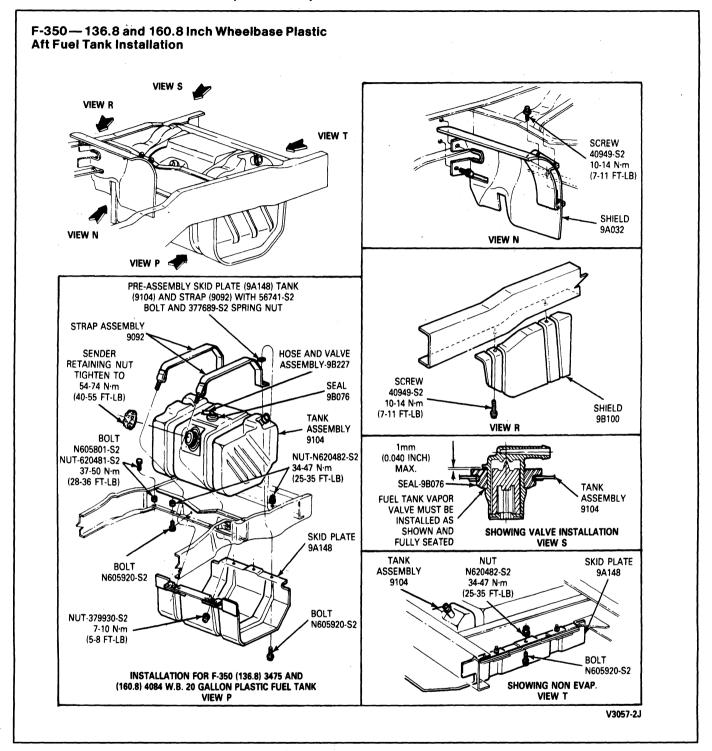
  Carefully lower the tank and disconnect the vent tube(s) from the vapor emission control valve in the top of the tank. Complete removing the filler pipe if not possible in step 6. Remove the skid plate and tank from under the vehicle.

  Disassemble the skid plate from the tank.









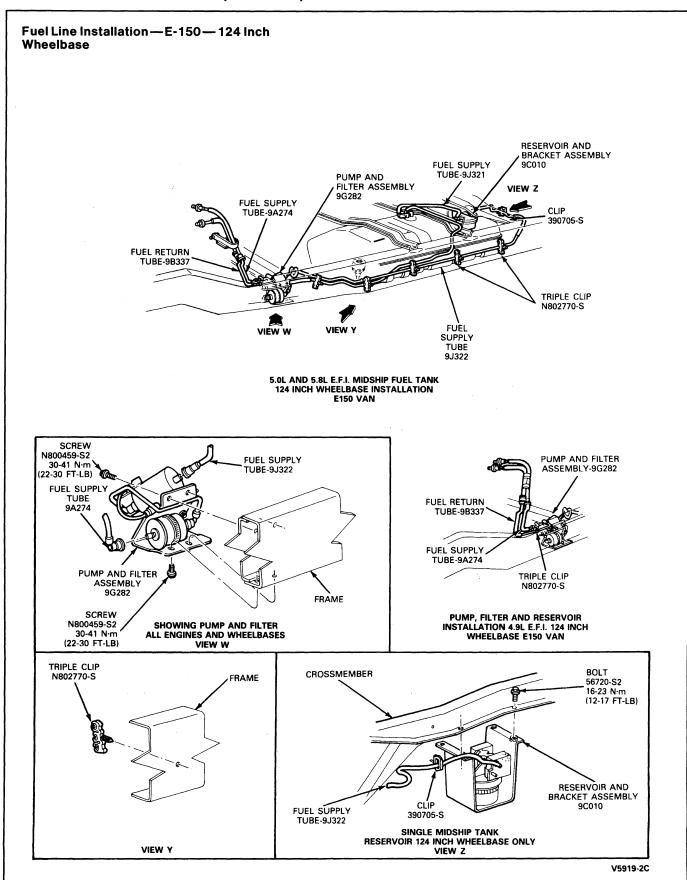
#### Installation

- If the tank or vapor emission control valve is being replaced, follow the installation procedures in the illustrations under Emission System in this section. Install new support strap insulation as required.
- If installing the plastic-type tank, assemble the skid plate and support straps to the tank.
- Raise the tank skid plate and support assembly and attach the vent hose(s) to the vapor emission control valve.
- 4. Start the tank neck into the hose.

- Position the tank assembly filler against the top straps of the frame. Install the attaching bolts and nuts using thread adhesive (such as Locktite).
   Tighten the attaching bolts and nuts to 37-50 N·m (27-37 ft-lb).
  - NOTE: The plastic tank attaching bolts and nuts do not utilize thread adhesive. Tighten these bolts and nuts to 34-47 N·m (25-35 in-lb).
- Insert the rubber inner hose inside the tank filler neck and connect the filler pipe hose. Tighten the clamps to 3-4 N-m (25-35 in-lb).
- 7. If the fuel gauge sending unit was removed, ensure all the old gasket material has been removed from the unit mounting surface on the tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure with the retaining ring.

- 8. Connect the fuel gauge sending unit electrical connector to the sending unit.
- 9. Connect the fuel lines at the fuel gauge sending unit. Install the drain plug, if so equipped.
- 10. Connect the vehicle battery ground cable removed in Removal step 2.
- 11. Fill the tank and check all connections for leaks.
- 12. Lower the vehicle.

| Aft-Of-Axle Fuel Tank—E-150—E-3       | 50 |
|---------------------------------------|----|
| Refer to the following illustrations. |    |

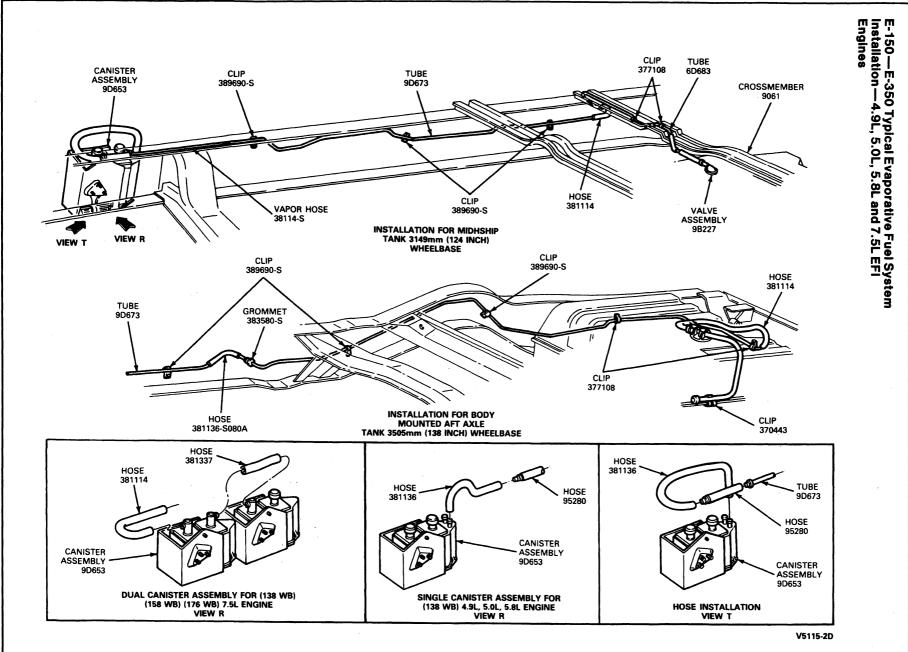


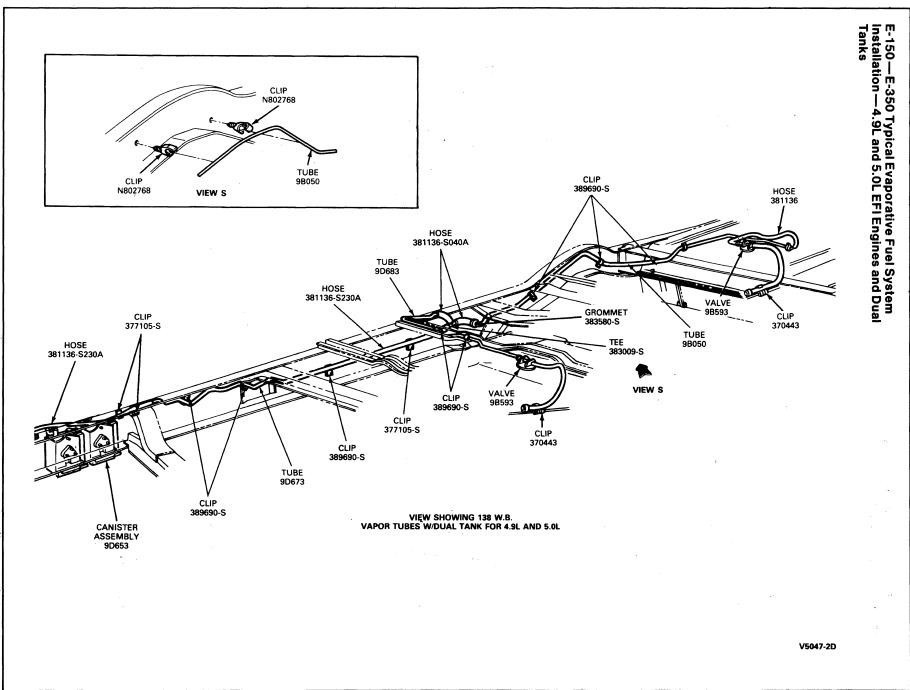
REMOVAL

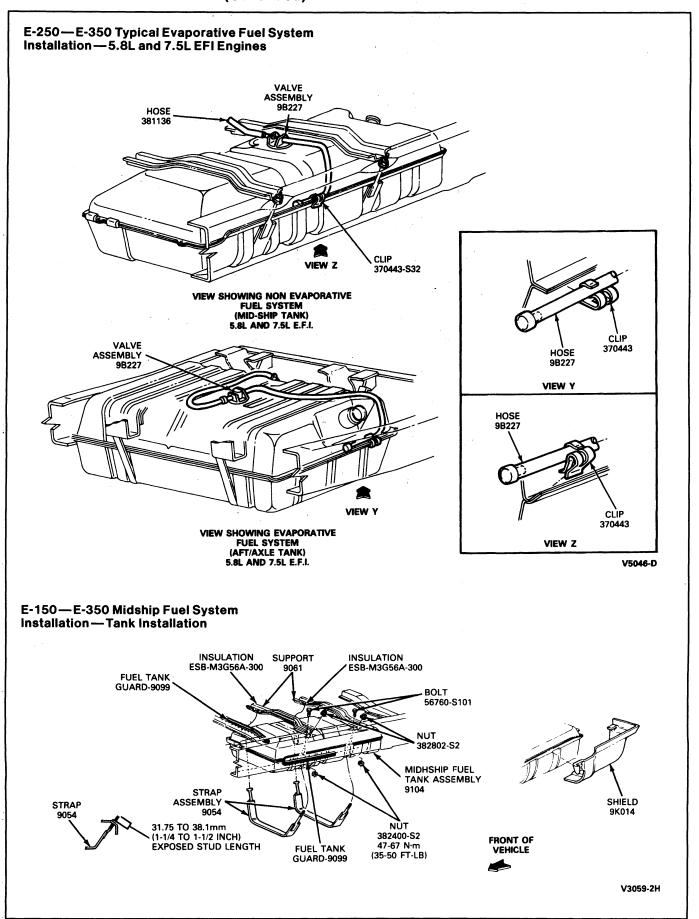
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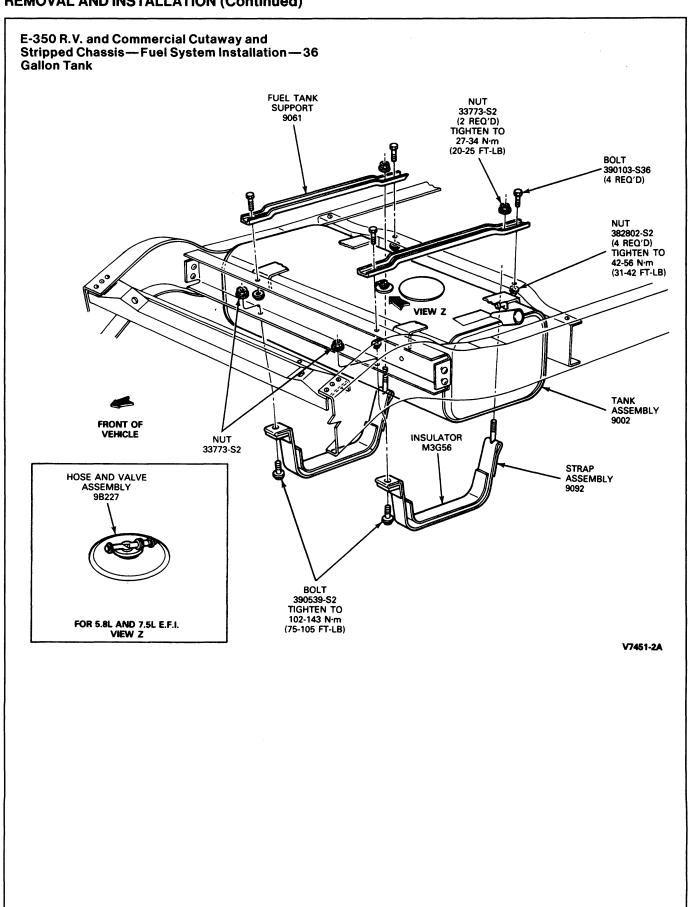
**INSTALLATION** (Continued)

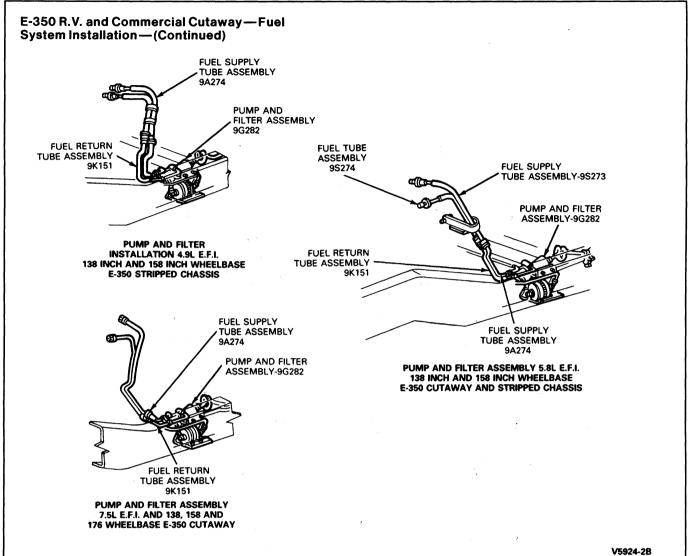
#### Fuel Line Installation Wheelbase CLIP 390705-S TRIPLE CLIP N802770-S PUMP AND FILTER ASSEMBLY-9G282 **FUEL SUPPLY** TUBE-9A274 -E-150-TRIPLE CLIP CLIP N802770-S 390705-S DUAL TANK FUEL SYSTEM ·E-350 138 Inch VIEW V 138 INCH WHEELBASE VANS/CLUBWAGON RESERVOIR AND BRACKET ASSEMBLY FUEL SUPPLY PUMP SUPPLY 9C011 TUBE-9A274 TUBE-9A274 PUMP AND FILTER ASSEMBLY-9G282 PUMP AND FILTER ASSEMBLY-9G282 **FUEL RETURN** TUBE-9K151 **FUEL SUPPLY** AND RETURN ASSEMBLY RESERVOIR AND 9J337 BRACKET ASSEMBLY RESERVOIR AND BRACKET **FUEL RETURN** 9C010 ASSEMBLY-9C010 TUBE-9K151 SINGLE AFT AXLE TANK FUEL SYSTEM PUMP FILTER AND RESERVOIR INSTALLATION 138 INCH WHEELBASE 4.9L E.F.I. 138 INCH WHEELBASE VANS/CLUBWAGONS **VANS/CLUB WAGONS FUEL SUPPLY** SCREW **SCREW** 56720-S2 TUBE-9A274 56720-S2 **FUEL SUPPLY AND** RESERVOIR AND RETURN ASSEMBLY-9H334 PUMP AND FILTER BRACKET ASSEMBLY ASSEMBLY-9G282 9C010 FRAME FRAME FRAME **FUEL SUPPLY AND** RETURN ASSEMBLY 9J337 **FUEL RETURN** TUBE-9K151 FUEL SUPPLY AND RESERVOIR AND BRACKET ASSEMBLY RETURN ASSEMBLY PUMP AND FILTER ASSEMBLY 9J337 9C011 7.5L E.F.I., 138 INCH WHEELBASE VANS/CLUBWAGONS DUAL TANK RESERVOIR VIEW V SINGLE AFT AXLE TANK RESERVOIR VIEW U V5920-2B











V5924-28

Gasoline Engines

REMOVAL AND INSTALLATION (Continued)

V5923-2B

#### E-350 R.V. and Commercial Cutaway— System Installation—(Continued) FUEL RETURN-TO-TANK TUBE ASSEMBLY **FUEL RETURN TUBE** 9A337 ASSEMBLY-9J324 **FUEL SUPPLY TUBE** ASSEMBLY-9J321 **FUEL TANK OUTLET TUBE FUEL SUPPLY TUBE** 9236 ASSEMBLY-9J322 **FUEL RETURN-TO-TANK** VIEW Y ASSEMBLY-9A337 VIEW SHOWING FUEL LINE INSTALLATION FOR 138 INCH WHEELBASE E-350 CUTAWAY-STRIPPED CHASSIS **FUEL RETURN TUBE** ASSEMBLY 9K151 VIEW X **FUEL RETURN** RESERVOIR AND BRACKET TUBE ASSEMBLY **FUEL TANK** ASSEMBLY-9C010 9J324 **OUTLET TUBE** 9236 -Fuel **FUEL SUPPLY TUBE** ASSEMBLY-9J322 VIEW Y **FUEL RETURN-TO-TANK FUEL SUPPLY** ASSEMBLY-9A337 TUBE ASSEMBLY RESERVOIR AND BRACKET 9J321 **FUEL RETURN** TUBE ASSEMBLY **ASSEMBLY** 9C010 9K151 VIEW SHOWING FUEL LINE INSTALLATION FOR 158" WHEELBASE E-350 CUTAWAY-STRIPPED CHASSIS **FUEL RETURN FUEL TANK** TUBE ASSEMBLY FUEL SUPPLY TUBE ASSEMBLY-9J322 **OUTLET TUBE** 9J324 9236 VIEW Y FUEL SUPPLY TUBE ASSEMBLY FUEL RETURN VIEW SHOWING FUEL LINE INSTALLATION FOR 176 INCH TUBE ASSEMBLY RESERVOIR AND BRACKET WHEELBASE E-350 CUTAWAY VIEW X 9J321 ASSEMBLY-9C010 9K151 CLIP 390705-S CLIP 390705-S CLIP N802770-S

VIEW Z

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VIEW X

VIEW Y

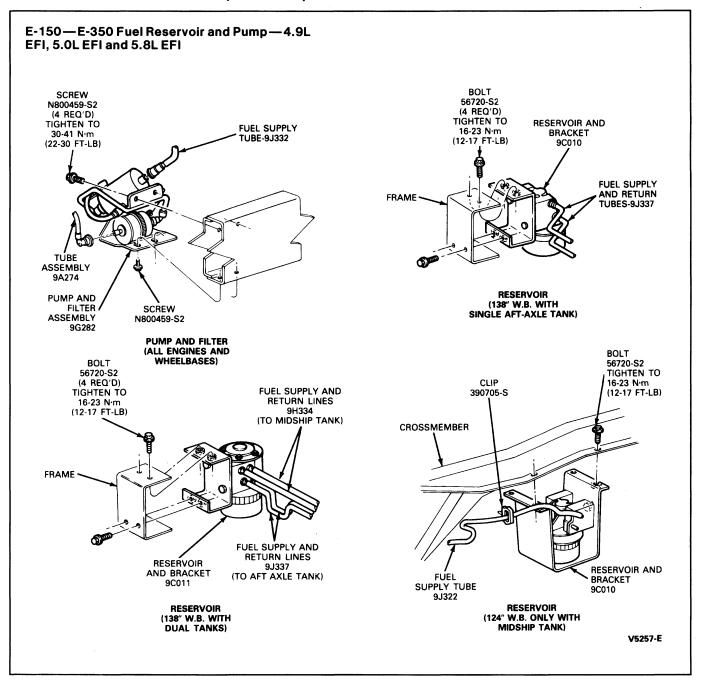
REMOVAL

AND

**INSTALLATION (Continued)** 

#### E-150—E-350 Fuel System and 5.8L EFI **FUEL TUBE** CLIP FUEL PUMP AND **FUEL SUPPLY AND ASSEMBLY** 390705-S RETURN TUBES BRACKET ASSEMBLY **9S273** 9G282 9H334 SUPPORT **FUEL SUPPLY** FUEL PUMP AND BRACKET TUBE-9J322 BRACKET ASSEMBLY 9D319 9G282 TUBE ASSEMBLY 9J338 FUEL SUPPLY FUEL TUBE TUBE-9A274 ASSEMBLY 9S274 **FUEL SUPPLY** AND RETURN TUBES 9J337 CLIP **FUEL RETURN** .390705-S LINE-9K151 RESERVOIR AND FUEL SUPPLY BRACKET ASSEMBLY 4.9L EFI, 5.0L EFI TUBE-9A274 CLIP 9C010 CLIP RESERVOIR AND N802770-S CLIP N802770-S BRACKET-9C011 N802270-S PUMP AND FILTER ASSEMBLY, AND RESERVOIR INSTALLATION (4.9L EFI ENGINE SAME AS 5.0L **FUEL RETURN** INSTALLATION FOR 138" W.B. WITH DUAL TUBE-9K151 **EFI ENGINE INSTALLATION EXCEPT AS SHOWN)** TANKS (5.0L AND 5.8L SHOWN) **FUEL** SUPPLY **BRACKET** TRIPLE TUBE 9D319 CLIP 9A274 N802770 FUEL RETURN TUBE 9K151 RESERVOIR 9C010 SINGLE AFT AXLE TANK FUEL SYSTEM TUBE ASSEMBLY 138" W.B., VANS/CLUBWAGONS (SUPPLY)-9S273 **FUEL SUPPLY FUEL PUMP AND** RESERVOIR AND BRACKET **TUBE-9J321** FILTER ASSEMBLY ASSEMBLY-9C010 TUBE ASSEMBLY TRIPLE CLIP CLIP 9G282 (RETURN)-9S274 N802770-S CLIP N802770-S 390705-S BRACKET 9D319 FRONT OF VEHICLE FUEL SUPPLY LINE-9J322 **FUEL RETURN** VIEW W TUBE ASSEMBLY (SUPPLY)-9A274 LINE TRIPLE CLIP 9B377 N802770-S TUBE ASSEMBLY PUMP AND FILTER ASSEMBLY AND RESERVOIR (RETURN)-9K151 VIEW W INSTALLATION (5.0L AND 5.8L EFI ENGINE) WITH 124" W.B. V5315-2D

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# Aft Axle Body-Mounted Tanks

#### Removal

- Drain the fuel into a suitable container by siphoning through the fuel line at the fuel reservoir connection.
- 2. Raise the rear of the vehicle.
- To avoid electrical sparking at the tank, disconnect the ground cable on the vehicle battery. Then disconnect the fuel gauge sending unit wires at the fuel tank.
- 4. Loosen the clamps on the fuel filler hose and vent hose at the tank neck. Disconnect the hoses from the tank.
- Remove the fuel line hairpin clips (plastic connectors) or use the plastic tool (steel connectors), and disconnect the fuel lines from the fuel gauge sending unit.
- 6. Support the tank in position. Remove the nuts that attach the mounting straps to the "T" bolts.

- NOTE: The "T" bolts are attached to body brackets located at the rear of the tank. Disengage the straps from the T-bolts and the front body brackets. Lower the tank enough to gain access to the vapor valve.
- Disconnect the carbon canister hose from the vapor control valve.
- 8. Lower the fuel tank and remove it from underneath the vehicle.
- If the fuel gauge sending unit is to be removed, turn the unit retaining ring counterclockwise and remove the sending unit retaining ring and gasket.
- If the vapor control valve is to be removed, pull it out of the seal located in the top of the tank and remove the seal.

#### Installation

- If the fuel gauge sending unit was removed, scrape away the old gasket material from the unit mounting surface on the fuel tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure with the retaining ring.
- If the vapor control valve was removed, install the seal in the tank opening and press-fit the valve into place.
- Attach the front ends of the mounting straps to the front body brackets.
- Raise the tank high enough to connect the carbon canister hose to the vapor valve. Connect the hose.
- Secure the strap ends to the T-bolts with the attaching nuts. Tighten nuts to 42-46mm (1.65-1.85 inch) exposed thread length.
- Connect the fuel lines to the fuel gauge sending unit.
- Connect the fuel filler hose and vent hose to the filler neck and vent neck at the tank. Tighten hose clamps to 3-4 N-m (25-35 in-lb).
- 8. Connect the vehicle battery ground cable removed in step 2 of the removal procedure. Connect the fuel gauge sending unit wires.
- 9. Fill the tank and check all connections for leaks.

### **Aft Axle Frame-Mounted Tank**

### Removal

- Drain the fuel into a suitable container by siphoning through the fuel line at the fuel reservoir connection.
- 2. Raise the rear of the vehicle.
- To avoid electrical sparking at the tank, disconnect the ground cable on the vehicle battery.

- 4. Loosen the clamps on the fuel filler hose and vent hose at the fuel filler pipe assembly. Disconnect the hoses from the pipe assembly.
- Disconnect the fuel lines, supply and return, at the front fuel tank support, NOT at the fuel sender.
- Disconnect the vapor hose at the vapor tube connecting to the carbon canister. If there is a secondary hose, disconnect it from the fuel tank support crossmember.
- 7. Support the fuel tank in position, and loosen the strap attachment nut (at the rear) that attaches the tank strap to the upper support. Disconnect the bolt that attaches the tank strap to the front crossmember (pivot strap to the rear of the vehicle). Lower the tank enough to gain access to the fuel gauge. Disconnect the fuel gauge sending unit wires at the fuel tank.
  - NOTE: F-Super Duty Motorhome chassis requires the removal of the front and rear attaching bolt and front heat shield.
- 8. Lower the fuel tank and remove it from underneath the vehicle.
- 9. If the fuel gauge sending unit or the in-tank fuel pump, is to be removed from the tank, disconnect the supply, return and auxiliary power take off lines from the fuel gauge sending unit. Remove six bolts (1/4 inch-20) or ten bolts (F-Super Duty Motorhome Chassis). Using care, remove fuel sender avoiding damage to the float and filter; also remove the fuel sender gasket.
- If the upper support or the rear reinforcement is to be removed, remove nut (hold bolt) that attaches the rear reinforcement and the upper support to the frame rear crossmember.
- 11. Remove nut that attaches the upper support to the front crossmember and remove the support.
- If the rear reinforcement is to be removed, remove bolt (weld nut) that attaches the reinforcement to the frame siderail.
- If the vapor control valve is to be removed, pull it out of the seal located in the top of the tank, and remove the seal.

#### Installation

- If rear reinforcement was removed, install new bolt (weld nut) attaching reinforcement to frame siderail.
- Attach nut that retains the upper support to the front crossmember.
- If upper support or the rear reinforcement was removed, attach the hold bolt that retained the rear reinforcement and the upper support to the frame rear crossmember.

- 4. If the fuel gauge sending unit was removed, scrape away all the old gasket material from the unit mounting surface on the fuel tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure with the retaining ring. Retighten the six retaining bolts to 10-13 N-m (85-115 ft-lb). Connect the fuel gauge sending unit wire.
- If the vapor valve was removed, install new seal in the tank top opening and press fit the valve into place.
- Raise the fuel tank high enough to connect the vapor hose to the vapor tube. Support tank in position and tighten the strap attachment bolts (at the front) to 102-142 N·m (75-105 ft-lb).
   Tighten the rear nuts (at the rear) to 27-34 N·m (20-25 ft-lb).
  - NOTE: For F-Super Duty Motorhome chassis vehicles, attach front and rear mounting bolts and reinstall front heat shield.
- Attach the fuel filler hose and vent hose at the pipe assembly and tighten the clamps to 34-47 N·m (20-25 ft-lb).
- 8. Connect the vehicle battery ground cable.

#### Midship Tank

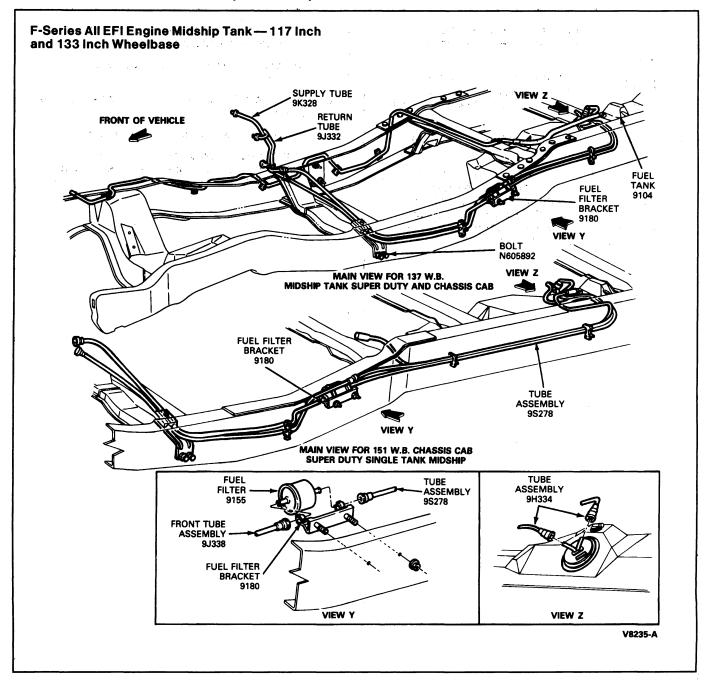
#### Removal

- Drain the fuel into a suitable container by siphoning through the fuel line at the reservoir connection.
- 2. Raise the vehicle.
- To avoid electrical sparking at the tank, disconnect the ground strap on the vehicle battery. Then disconnect the fuel gauge sending unit wires at the fuel tank.

- 4. Support the tank in position. Disengage the mounting strap ends attached to the frame side rail. Remove the other end from the tank support by rotating the strap to disengage the "T" shaped hook end.
- Lower the tank enough to gain access to the vapor valve, fuel filler hose, fuel vent hose, and fuel lines. Loosen the attaching clamps and push connectors, and disconnect the lines. Disconnect the vapor valve hose from the carbon canister tube.
- Lower the tank and remove it from underneath the vehicle.
- If the fuel gauge sending unit is to be removed, turn the retaining ring counterclockwise and remove the sending unit, retaining ring and gasket.
- If the vapor control valve is to be removed, pull it out of the seal located in the tank top and remove the seal.

#### Installation

- If the fuel gauge sending unit was removed, scrape away all the old gasket material from the unit mounting surface on the fuel tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure with the retaining ring.
- If the vapor valve was removed, install the seal in the tank opening and press fit the valve into place.
- If the insulation tape was worn or damaged, remove the material and install new pieces approximately 419mm (16.5 inches) long, (two pieces).



- Attach the "T" hook mounting strap ends in the tank supports. Raise the tank high enough and connect the vapor hose to the carbon canister line. Also connect the fuel filler hose, fuel vent hose, and fuel lines. Tighten the clamps that attach the hoses to the mating tank parts to 3-4 N-m (25-35 in-lb).
- Attach the mounting straps stud end to the frame side rail with attaching nuts and tighten to 32-38mm (1.25-1.50 inches) exposed thread length.
- Connect the vehicle battery ground cable removed in step 3 of the removal procedure. Connect the fuel gauge sending unit wire.
- 7. Fill the tank and check all connections for leaks.

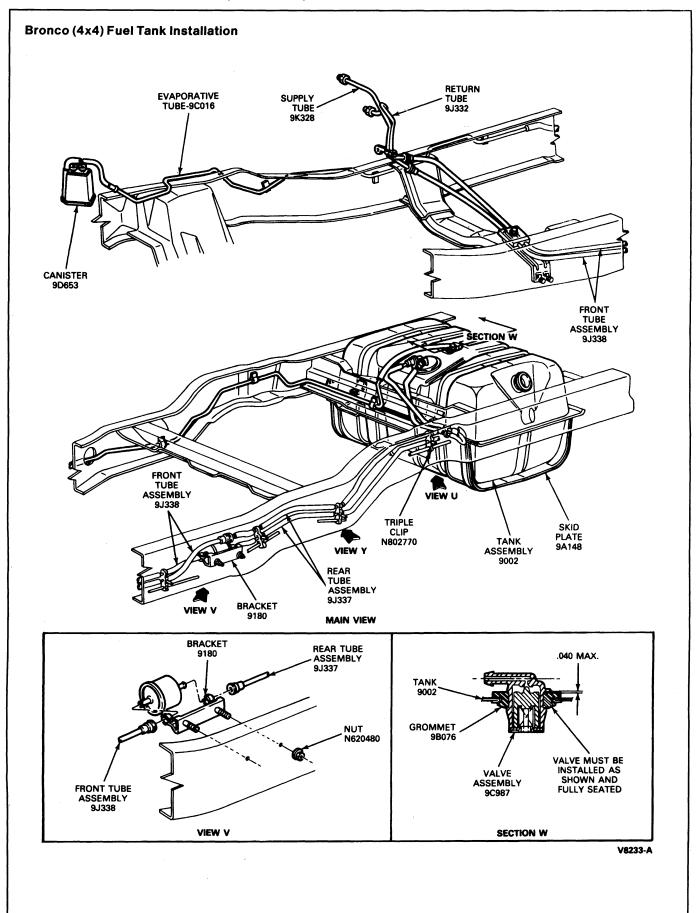
# Bronco Fuel System—5.0L and 5.8L Engine Removal

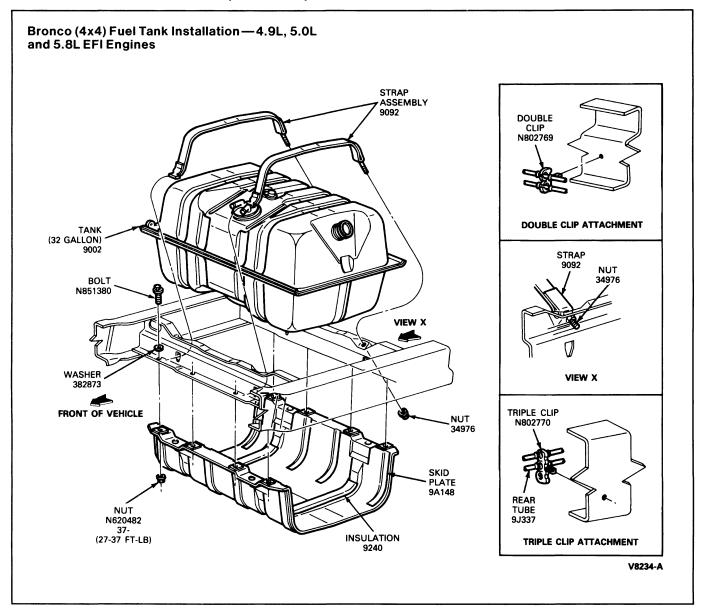
- Drain the fuel into a suitable container at the fuel hose between the fuel pump and fuel tube.
- 2. Raise the rear of the vehicle.

- To avoid electrical sparking at the tank, disconnect the ground cable on the vehicle battery.
- Loosen the clamp on the fuel filler pipe hose at the filler pipe and disconnect the hose from the pipe by pulling along the internal fuel tube from the tank filler neck.
- Disconnect the fuel lines at the fuel gauge sending unit.
- Support the tank and remove the lower support bracket bolts or skid plate bolts. Remove the support assembly or skid plate attaching nut at each tank mounting strap. Lower the support assemblies, and lower the tank enough to gain access to the tank vent hose.

- 7. Disconnect the fuel sending unit electrical connector at the fuel tank.
- Disconnect the fuel tank vent hose at the top of the tank.
- Disconnect the fuel tank-to-vapor separator lines at the fuel tank.
- 10. Remove the fuel tank from under the vehicle.

If the fuel gauge sending unit is to be removed, turn the unit retaining ring. Remove sending unit and gasket.





#### Installation

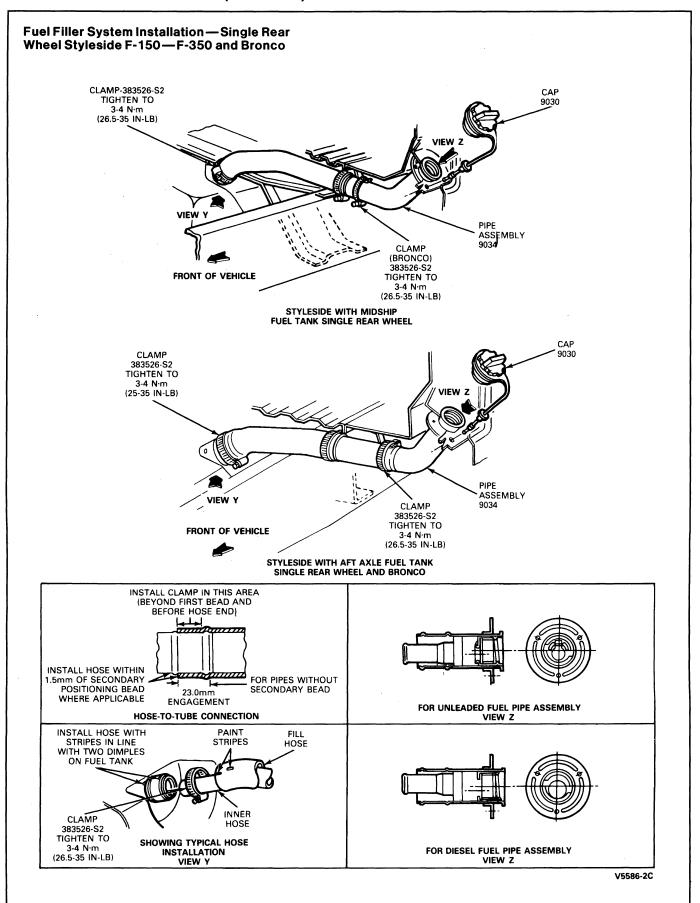
- If the fuel gauge sending unit was removed, make sure all the old gasket material has been removed from the mounting surface on the fuel tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure with the retaining ring.
- Position the forward edge of the tank and skid plate, if so equipped, to the frame crossmember, support the tank and connect the vent hose to the top of the tank.
- 3. Connect the fuel sender electrical connector.
- Position the tank, skid plate and straps, and install the attaching parts. Tighten the attaching bolts and nuts to 37-50 N·m (27-37 ft-lb) using Ford Threadlock and Sealer EOAZ-19554-A or equivalent.

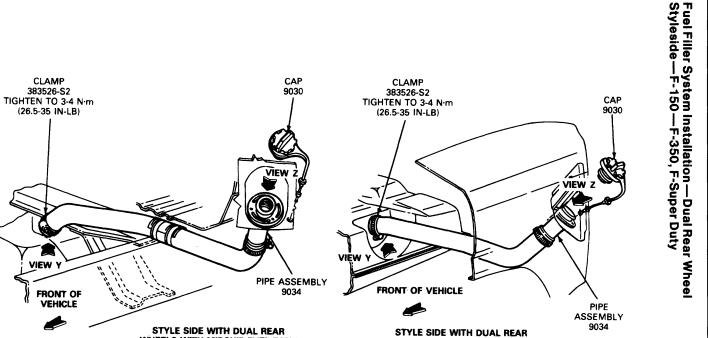
- 5. Connect the fuel lines to the fuel sender.
- Insert the internal fuel tube into the tank filler neck. Connect the filler pipe-to-tank hose and vent tube at the filler pipe and install the hose clamp. Tighten to 3-4 N·m (25-35 in-lb).
- 7. Connect the vehicle battery ground cable.
- 8. Fill the tank and check all connections for leaks.
- 9. Lower the vehicle.

## **Filler Pipes**

F-150—F-350, F-Super Duty, Bronco and E-Series Cutaway and Stripped Chassis

Procedures are the same for the aft axie and midship fuel filler pipe.



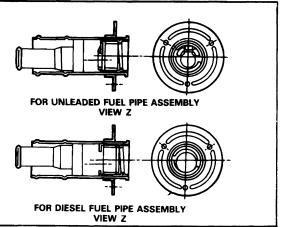


INSTALL HOSE WITH STRIPES ON FUEL TANK

ON FUEL TANK

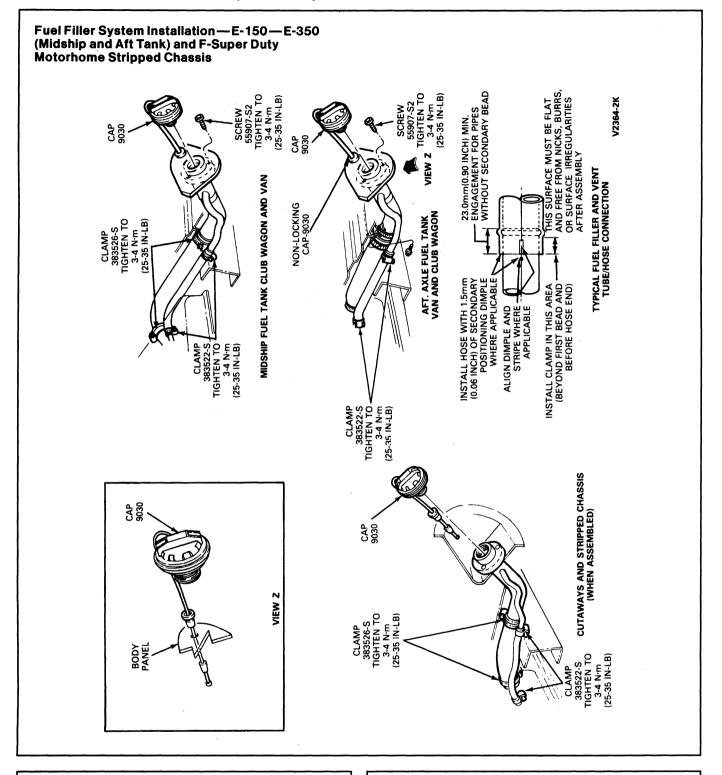
INNER PAINT STRIPES

SHOWING TYPICAL HOSE INSTALLATION VIEW Y



WHEELS WITH AFT AXLE FUEL TANK

V5587-2B



# Removal

- Drain fuel to a level (approximately 3/4 full) below the fuel tank filler connection by using the fuel hose at the fuel pump-to-fuel tube connection.
- On Econoline, loosen clamp attaching filler pipe to tank fuel filler neck and vent hoses.
- Detach fuel filler pipe from support bracket and disconnect fuel filler and vent hoses.
- On F-Series, loosen clamp attaching filler pipe and disconnect hose from the pipe, pulling the internal fuel tube from tank filler neck.
- 5. Remove the three retainer screws that attach the filler pipe flange to the fuel filler housing.

- 6. Remove fuel filler pipe from vehicle.
- Remove hose and clamps. Replace all damaged or worn parts.

#### Installation

- Position fuel filler pipe in vehicle, being careful to position neck on vehicles wiht internal vent tube.
- Position fuel filler vent hoses on filler pipe of vehicles with external vent hose.
- Position clamps on filler pipe and vent hoses.
- Secure fuel filler pipe to mounting brackets. For F-150—F-350 and Bronco, tighten screws to 2-3 N·m (15-25 in-lb).
- Adjust hose to obtain snug filler pipe installation. Tighten hose clamps to 3-4 N·m (25-35 in-lb). Make certain clamps are forward of flange on filler pipe to ensure a leakproof connection.
- Fill tank with fuel. Install filler cap; check for leaks.

# E-150—E-350 Vans and Club Wagons Removal

- Drain the fuel into a suitable container by siphoning through the fuel hose at the supply line at the fuel reservoir connection.
- Remove the three retainer screws that attach the filter pipe flange to the fuel filler pipe housing.
- Loosen the clamps that attach the filler pipe to the fuel filler hose and the fuel vent hose.
   Disconnect the hoses.
- Loosen the clamp that attaches the filler pipe to the support bracket at the underbody flange (aft / axle only).
- Remove the fuel filler pipe assembly by rotating it through the opening in the underbody below the body housing assembly.

## Installation

- Install the fuel filler pipe assembly by inserting it through the underbody opening and rotating it to butt the pipe flange against the fuel filter pipe housing.
- 2. Attach the pipe flange to the fuel filter pipe housing with three retaining screws. Tighten screws to 3-4 N·m (25-35 in-lb).
- 3. Tighten the clamps that attach the filler pipe to the support bracket at the underbody flange to 3-4 N·m (25-35 in-lb) (aft/axle only).
- Connect the fuel filler hose and the fuel vent hose to the fuel filler assembly. Tighten the attaching clamps to 3-4 N·m (25-35 in-lb).
- Fill the tank, install fuel filler cap and check all connections for leaks.

#### **MAJOR SERVICE OPERATIONS**

#### **Evaporative Emission System**

WARNING: THE EVAPORATIVE EMISSION SYSTEM CONTAINS FUEL VAPOR AND CONDENSED FUEL VAPOR. ALTHOUGH NOT PRESENT IN LARGE QUANTITIES, IT STILL PRESENTS THE DANGER OF EXPLOSION OR FIRE. DISCONNECT THE BATTERY GROUND CABLE FROM THE BATTERY TO MINIMIZE THE POSSIBILITY OF AN ELECTRICAL SPARK OCCURRING, POSSIBLY CAUSING A FIRE OR EXPLOSION IF FUEL VAPOR OR LIQUID FUEL ARE PRESENT IN THE AREA.

Evaporative emission components have been designed and tested to exceed 193, 121 Km (120,000 miles) or 10 years of vehicle use. No maintenance or servicing should be required. However, if components have been damaged and are to be replaced, or if disconnection or removal is required for diagnosis, the following techniques should be used to aid servicing the system.

Typical evaporative emission systems are shown in the illustrations under Emission System in the Diagnosis portion of this section.

To disconnect a hose from any component, refer to the following:

- Securely grip component with one hand, and hose with the other hand as close as possible to connection.
- Sharply twist hose along its axis to "break" the temporary bond between hose and component. (No adhesive is used to make hose connections during vehicle assembly, but natural aging of the connections causes a temporary bond to exist.)
- It is important to "break free" the hose at its connection point as indicated in step 2. If the joint is stubborn and the above method does not work, grip the hose with a pair of pliers directly over the joint and twist again.
- Once the hose / component joint has been broken, disconnect by securely gripping the component with one hand and hose with the other. Twist hose and at the same time pull apart.

WARNING: MOST CONNECTIONS IN THE EVAPORATIVE EMISSION SYSTEM ARE VERY SECURE. A STRONG PULLING AND SIMULTANEOUS TWISTING ACTION IS REQUIRED TO DISCONNECT. WHEN DISCONNECTION OCCURS, BOTH HANDS COULD SHARPLY AND UNCONTROLLABLY MOVE IN THE DIRECTION OF EACH HAND'S PULLING. BE CAREFUL THAT NO SHARP OR POSSIBLE DAMAGING OBJECTS ARE IN LINE WITH THE DIRECTION OF PULL TO PREVENT PHYSICAL INJURY AND/OR DAMAGE TO THE OBJECTS THAT WILL BE IMPACTED BY THE HANDS WHEN DISCONNECTION OCCURS.

To reconnect a hose to a component, wet the hose and push onto component.

# **MAJOR SERVICE OPERATIONS (Continued)**

Use Ford-approved fuel hoses for replacement of damaged hoses. Original equipment hoses are designed to resist most environmental conditions encountered in the evaporative emission system.

#### **Fuel Tanks**

Fuel tanks do not require special service procedures and may be steam-cleaned and/or serviced using standard procedures. After steaming, allow time to thoroughly air dry. The vapor valve assembly and fuel sender assembly should be removed prior to steaming.

CAUTION: Leaks or damage to the polyethylene fuel tanks are not repairable. This applies to certain F-Series with plastic fuel tanks including all polyethylene portions of the tank body and fittings. Tank replacement is the only acceptable service. There are no reliable repair procedures that meet the same standards as a new tank. Methods which appear to work may not function for the long term or after being subjected to normal use or abuse.

## **Electric Fuel Pumps**

An electric fuel pump is located in the fuel tank. The pump is attached to the fuel tank as part of the sender unit. The fuel tank must be removed to service the fuel pump. Care should be taken during installation due to the hose and wire routing on the tank. Be sure all hoses and wires are routed properly. Check the fuel line connections for leaks.

NOTE: Remove the fuel pump prior to steaming the fuel tank.

For electric fuel pump service, refer to Electric Fuel Pump—Econoline or Fuel Delivery Module (FDM)—High Pressure in the Diagnosis portion of this section.

WARNING: FUEL SUPPLY LINES ON VEHICLES EQUIPPED WITH FUEL INJECTED ENGINES WILL REMAIN PRESSURIZED FOR LONG PERIODS OF TIME AFTER ENGINE SHUT-DOWN. THE PRESSURE MUST BE RELIEVED BEFORE SERVICING THE FUEL SYSTEM.

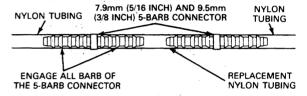
Refer to Fuel System Pressure Relief.

#### **Fuel Lines**

Vehicles equipped with nylon fuel tubes and push connect fittings have three types of service that can be performed to the fuel lines: replacing nylon tubing (splicing nylon to nylon), replacing push connector fittings, and replacing damaged push connect tube end.

# **Splicing Nylon to Nylon**

- Relieve fuel system pressure as outlined. Read cautionary note prior to relieving pressurized fuel system.
- Cut out damaged section of tubing and retain as a quide.
- 3. Cut a section of service tubing (type 11 or 12 nylon available in 6.3mm (1/4 inch), 9.5mm (3/8 inch), 7.9mm (5/16 inch) sizes to the same length as the damaged section of tubing.
- Select the proper 9.5mm (3/8 inch) or 7.9mm (5/16 inch) barbed connectors for completing the splice. Two connectors are required for each splice.



7.9mm (5/16 INCH) AND 9.5mm (3/8 INCH) TUBING SPLICE-EFI

V5111-1B

NOTE: To make hand insertion of the barbed connectors into the nylon easier, the tube end may be soaked in a cup of boiling water for one minute immediately before pushing the barbs into the nylon using Rotunda Tool 134-00001 or equivalent to assist assembly.

- Install the barbed connectors into each end of the replacement tubing using boiling water and special tool as outlined.
- 6. Install clips onto any tubes which might be difficult to access once the final splices are completed.
- Complete the splice of the replacement nylon to the original nylon tubing at both ends. Use the boiling water method and special tool as mentioned previously, to get the barbs totally engaged.
- Install any remaining clips which were removed for this service and check that the tubes are secure in the original clips.
- Start engine and check for leaks.

# **Replacing Damaged Push Connectors**

 Relieve fuel system pressure as outlined. Read the cautionary note prior to relieving the pressure in the fuel system.

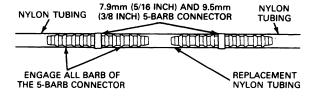
NOTE: Damaged push connectors must be discarded and replaced with new push connectors. If only the retaining clip is damaged, replace the clip.

# **MAJOR SERVICE OPERATIONS (Continued)**

- Disconnect the damaged push connector. Be sure to bend the shipping tab to the side before removing retaining clip. The spring lock connector requires the use of the Spring Lock Coupling Tool D87L-9280-A or B or equivalents.
- Select the proper size replacement push connector and nylon tube assembly. In some instances, the new connector will not be available with a nylon line attached. In this instance, it will be necessary to attach a section of line.
- Cut out a section of the original nylon tube to the same length as the nylon tube attached to the new push connector.
- Install proper barbed connector into the replacement nylon assembly.

NOTE: To make hand insertion of the barbed connectors into the nylon easier, the tube end may be soaked in a cup of boiling water for one minute immediately before pushing the barbs into the nylon using Rotunda Tool 134-00001 or the equivalent.

Complete the splice by connecting the barbed connector to the original nylon.



7.9mm (5/16 INCH) AND 9.5mm (3/8 INCH) TUBING SPLICE-EFI

V5111-1B

- Connect the new connector assembly to the tube end.
- 8. Check that the underbody clips are properly securing the fuel tubes.
- Start engine and check for fuel leaks.

# Replacing Damaged Steel Push Connect Tube Ends

- Relieve fuel system pressure as outlined. Read the cautionary note prior to relieving the pressure in the fuel system.
- Using a tube cutter, remove the damaged push connect tube end at a convenient distance from the end.
  - NOTE: Allow for adequate room to tighten a union with a wrench at this location.
- Choose a proper replacement push connect tube end.
- If required, form the new tube end to the same shape as the damaged tube end which was removed.
- 5. Select the proper size union and attach the new steel tube end to the original tube.
- Clean off the steel tube end and replace the push connector onto the tube. (A new retainer clip is recommended.)
- 7. Check that the fuel tubes are properly secured.
- Start engine and check for leaks.

# **SPECIFICATIONS**

STANDARD AND AUXILIARY FUEL TANKS — CAPACITY IN LITERS (GALLONS)

| Model                                     |  |                                    |  | {           | Advertised Tank Cap             |
|---|--|------------------------------------|--|-------------|---------------------------------|
| Series                                    | W.B. mm (In)                           | Body Style                         | Location                                   | Fuel Evap.  | Refill Liters (Gal.)            |
| E-150 Van                                 | 3150 (124)                             | All                                | Midship                                    | Х           | 68 (18.0)                       |
| E-150, 250, 350 Van<br>E-150, 250 Wagon   | 3505 (138)                             | All                                | Aft/Axle<br>Midship②                       | X<br>X      | 83 (22)<br>61 (16)              |
| 350 Cutaway & Stripped Chassis (§)        | 3505 (138)<br>4018 (158)<br>4470 (176) | All                                | Aft/Axle                                   | х           | 136(36)⑥                        |
| E-150, 250, 350<br>Super Van, Super Wagon | 3505 (138)                             | All                                | Aft/Axle<br>Midship ②                      | Х           | 83 (22)<br>61 (16)              |
| Bronco (4x4)                              | 2660 (104.7)                           | All                                | Aft/Axle 4                                 | Х           | 121 (32)                        |
| F-150 (4x2)                               | 2967 (116.8)                           | Reg. Cab                           | Midship ② Aft/Axle                         | X           | 64 (16.5)<br>69 (18.2)          |
|   | 3378 (133.0)                           | Reg. Cab                           | Midship ② Aft/Axle                         | X           | 72 (19)<br>69 (18.2)            |
| (4x4)                                     | 2967 (116.8)                           | Reg. Cab                           | Midship ① ② Aft/Axie ①                     | X           | N/A<br>69 (18.2)                |
|   | 3378 (133.0)                           | Reg. Cab                           | Midship①②<br>Aft/Axle①                     | X           | 72 (19)<br>69 (18.2)            |
| (4x2)                                     | 3526 (138.8)                           | Super Cab                          | Midship®<br>Aft/Axle                       | X           | 64 (16.5)<br>69 (18.2)          |
|   | 3937 (155.0)                           | Super Cab                          | Midship<br>Aft/Axle®                       | X           | 72 (19)<br>69 (18.2)            |
| (4x4)                                     | 3937 (155.0)                           | Super Cab                          | Midship①<br>Aft/Axle①⑧                     | X           | 72 (19)<br>69 (18.2)            |
| F-250 (4x2)                               | 3378 (133.0)                           | Reg. Cab                           | Midship<br>Aft/Axle®                       | X           | 72 (19)<br>69 (18.2)            |
|   | 3526 (138.8)                           | Super Cab                          | Midship<br>Aft/Axle®                       | X           | 64 (16.5)<br>69 (18.2)          |
|   | 3937 (155.0)                           | Super Cab                          | Midship<br>Aft/Axle®                       | X<br>X      | 72 (19)<br>69 (18.2)            |
| (4x4)                                     | 3378 (133.0)                           | Reg. Cab/<br>W/E4OD<br>Cab Chassis | Midship① Midship②⑧ Aft/Axle①               | X<br>X<br>X | 69 (18.2)<br>87 (23)<br>72 (19) |
|   | 3937 (155.0)                           | Super Cab                          | Midship①<br>Aft/Axle①⑧                     | X<br>X      | 72 (19)<br>69 (18.2)            |
| F-350 (4x2) and (4x4)                     | 3378 (133.0)                           | Reg. Cab/<br>W/E4OD<br>Cab Chassis | Midship<br>Midship (7) (4)<br>Aft/Axle (2) | X<br>X<br>X | 69 (18.2)<br>87 (23)<br>72 (19) |
|   | 3475 (136.8)                           | Cab Chassis                        | Midship<br>Aft/Axle 3 4                    | X           | 72 (19)<br>72 (19)              |
|   | 4084 (160.8)                           | Cab Chassis                        | Midship<br>Aft/Axle 3 4                    | X<br>X      | 72 (19)<br>72 (19)              |
|   | 3937 (155.0)                           | Crew Cab                           | Midship<br>Aft/Axle ②                      | X<br>X      | 72 (19)<br>69 (18.2)            |
| F-Super Duty                              | 3475 (136.8)                           | Chassis Cab                        | Midship<br>Aft/Axle②                       | X<br>X      | 72 (19)<br>72 (19)              |
|   | 4085 (160.8)                           | Chassis Cab                        | Aft/Axle②<br>Midship                       | X<br>X      | 72 (19)<br>72 (19)              |
| F-Super Duty<br>Motor Home Chassis        | 4521 (178)                             | Stripped Chassis                   | Aft/Axle(\$)                               | Х           | 284 (75)                        |
|   | 5283 (208)                             | Stripped Chassis                   | Aft/Axie(3)                                | X           | 284 (75)                        |

①R.P.O. Skid Plate Available w/4x4 Models. ②Steel Auxiliary Tank. ③Plastic Auxiliary. ④Standard Skid Plate on 4x4 Models.

CV2366-2M

<sup>§15</sup> Liters (4 Gal.) Throwaway Standard on RV Chassis/RV Cutaway, Commercial Cutaway, and Commercial Chassis.

Available on Cutaway and stripped chassis only.
 Standard Plastic Tank (Diesel Only).

Standard Dual Tanks.

NOTE:

All F-Series AFT/Axle Fuel Tanks are Standard R.P.O. is Midship (W.B. 3378 mm (133 in) and 2967 mm (117 in) only).

# **SPECIFICATIONS (Continued)**

| Description        | N-m   | Ft-Lb |
|--------------------|-------|-------|
| Fuel Line Fittings | 13-20 | 10-15 |

# **SPECIAL SERVICE TOOLS**

| Tool              | Description                          |
|-------------------|--------------------------------------|
| D85L-9974-B       | Adapter                              |
| T63P-9171-A       | Keystone Clamp Pliers                |
| T80L-9974-B       | Fuel/Reserve Gauge                   |
| T74P-9275-A       | Fuel Tank Sender Wrench              |
| D87L-9280-A       | Spring-Lock Coupling Tool - 3/8 inch |
| D87L-9280-B       | Spring-Lock Coupling Tool - 1/2 inch |
| T83P-19623-C      | Spring Lock Coupling Tools - 5/8 in. |
| Rotunda Equipment |                                      |
| 034-00002         | Fuel Storage Tanker                  |
| 014-00702         | Vacuum/Pressure Tester               |
| 007-00001         | Digital Volt-Ohm Meter               |
| 134-00001         | Fuel Line Installation Tool          |
| 018-00003         | Safety Can                           |

# SECTION 10-01B Fuel Tank, Pump, Lines and Filters—Diesel Engines

| SUBJECT                                       | PAGE      | SUBJECT                              | PAGE      |
|---|-----------|--------------------------------------|-----------|
| DESCRIPTION                                   |           | REMOVAL AND INSTALLATION             |           |
| Fuel Selector Valve (Vehicles with Dual Tanks |           | Filler Pipes                         | 10-01B-35 |
| Only)   | .10-01B-2 | Fuel Filter                          |           |
| Fuel Supply Pump                              | .10-01B-1 | Fuel Lines                           | 10-01B-44 |
| Fuel Tank Draining                            | 10-01B-2  | Fuel Lines and Hoses                 | 10-01B-11 |
| Fuel Tank Filling                             |           | Fuel Supply Pump                     | 10-01B-10 |
| Fuel Tanks and Lines                          | 10-01B-2  | Fuel Tanks                           |           |
| Fuel/Water Separator                          | 10-01B-4  | Major Service Operations             | 10-01B-44 |
| Push Connect Fittings                         | 10-01B-2  | Selector Valve — Auxiliary Fuel Tank | 10-01B-40 |
| DIAGNOSIS AND TESTING                         |           | SPECIAL SERVICE TOOLS                | 10-01B-47 |
| Fuel Pump                                     | 10-01B-4  | SPECIFICATIONS                       | 10-01B-46 |
| Fuel Valve System                             |           |                                      | 10-01B-1  |
|   |           |                                      |           |

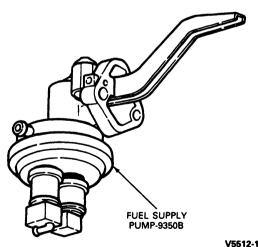
## **VEHICLE APPLICATION**

F-Series, Econoline—and Super Duty Series Vehicles **Equipped With Diesel Engines** 

# **DESCRIPTION**

# **Fuel Supply Pump**

The fuel supply pump is bolted to the right-front side of the cylinder block on the 7.3L—V-8 diesel engine.

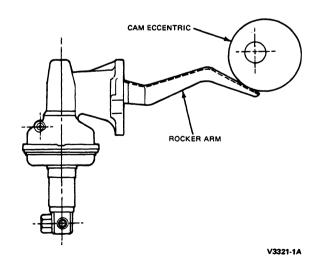


V5512-1A

The pump is mechanically operated by an eccentric cam located on the camshaft. The pump rocker arm riding against the eccentric provides the diaphragm up-and-down pumping motion.

The fuel supply pump cannot be disassembled for repairs and must be replaced if testing indicates it is not within performance specifications.

WARNING: NO SMOKING OR OPEN FLAME OF ANY TYPE SHOULD BE PRESENT WHEN WORKING NEAR FUEL OR FUEL VAPOR.



## **DESCRIPTION (Continued)**

#### **Fuel Tanks and Lines**

Typical fuel tank and line installations are shown under Removal and Installation. Refer to these illustrations and remove damaged or worn parts as necessary.

# **Push Connect Fittings**

Push connect fittings are used to make most fuel line connections in diesel fuel systems. These fittings must be serviced as outlined. Service is not possible if the fitting is damaged, except to replace a damaged retaining clip.

#### **Fuel Tank Filling**

Expansion of fuel due to temperature increases, or overfilling ("topping off") could cause fuel overflow at the filler cap when the vehicle is standing or the cap is removed. To minimize this condition, it is recommended that the amount of fuel put in the tank when filling be limited to the automatic pump shutoff. If vehicle has two tanks, use fuel from both tanks after fill-up to reduce fuel levels.

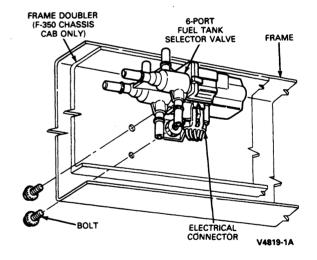
## **Fuel Tank Draining**

Use appropriate adapter to connect Rotunda Suction Pump 034-00006 or equivalent suction pump to the fuel hose (at the fuel sedimenter-to-fuel tube connection), and drain the fuel tank.

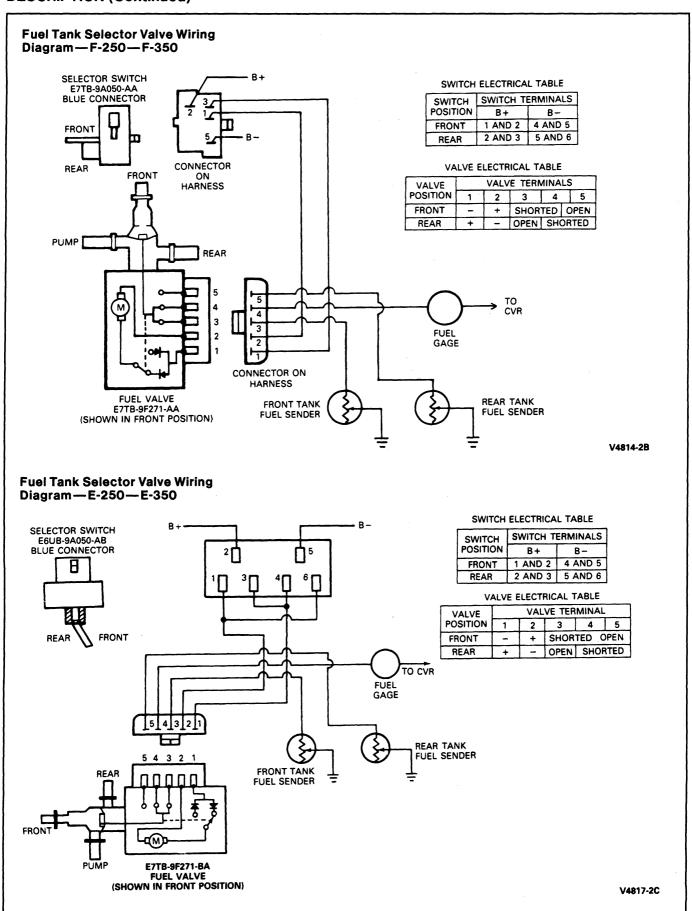
# Fuel Selector Valve (Vehicles with Dual Tanks Only)

The 6-port diesel fuel valve is powered by a small electric motor which opens and closes the valve ports. The supply and return ports for either tank open and close simultaneously. The valve is shifted to the front mode (that is the front supply and return ports open to the engine supply and engine return port respectively) by applying a positive 12 volts to terminal number 2 and ground to terminal number 1. When the valve reaches the front mode position, an internal switch opens the circuit and stops the motor. Returning the valve to the rear mode is accomplished by reversing power: positive 12 volts to terminal number 1 and ground to terminal number 2. Terminals 3 and 5 connect to the front and rear fuel tank senders respectively, and terminal 4 feeds the fuel gauge. In the front tank mode, an internal switch connects terminal 3 to terminal 4, thus supplying the front tank sender signal to the fuel gauge. Terminals 4 and 5 are connected in the rear tank mode. Therefore, a change in the fuel gauge reading (assuming at least 1/4 tank fuel level difference), means that the valve has shifted.

## Fuel Tank Selector Valve — Typical



# **DESCRIPTION (Continued)**



## **DESCRIPTION (Continued)**

Power is supplied to the fuel tank selector switch from the fuse panel when the ignition switch is in the ON position. This power goes through the fuel tank selector switch directly to the motorized fuel tank selector valve.

With the fuel tank selector switch in the front tank position, power is supplied from the selector switch to terminal number 2 of the fuel selector valve. The ground path is completed through terminal number 1 of the fuel tank selector valve and is grounded through the selector switch. This causes the fuel selector valve to rotate internally, opening the ports to the front tank position which allows fuel to flow through the fuel line to the engine.

With the fuel tank selector switch in the rear tank position, power is supplied from the selector switch to terminal number 1 of the fuel tank selector valve. The ground path is completed through terminal number 2 of the fuel tank selector valve and is grounded through the selector switch. This current path causes the motorized valve to rotate internally, opening the ports to the rear tank position which allows fuel to flow through the fuel line to the engine.

NOTE: When diagnosing the selector valve for failure to switch tanks and voltage is on terminals number 1 and number 2 of the valve, ensure the ground wire is attached below the instrument panel.

#### Fuel/Water Separator

Water should be drained from the engine mounted fuel/water separator whenever the warning lamp comes on or every 8047 km (5000 miles). More frequent drain intervals may be required depending on fuel quality and vehicle usage.

The instrument panel warning lamp (WATER IN FUEL) will glow when approximately 0.1 liter (0.1 quart) of water has accumulated in the sedimenter. When the warning lamp glows, shut off the engine as soon as safely possible.

## **Drain Procedure**

Refer to Section 03-01D, Engine, 7.3L—Diesel.

#### DIAGNOSIS AND TESTING

#### **Fuel Pump**

If the fuel pump is damaged or worn, it normally will not deliver any fuel or will not deliver adequate fuel to sustain high engine speeds or loads.

When an engine has a lean (fuel starving) condition, the fuel supply pump is often suspected to be the problem. Similar symptoms will be present if the fuel filter is plugged or restricted, if the fuel / water separator is contaminated, or if fuel lines and hoses are leaking, kinked or restricted.

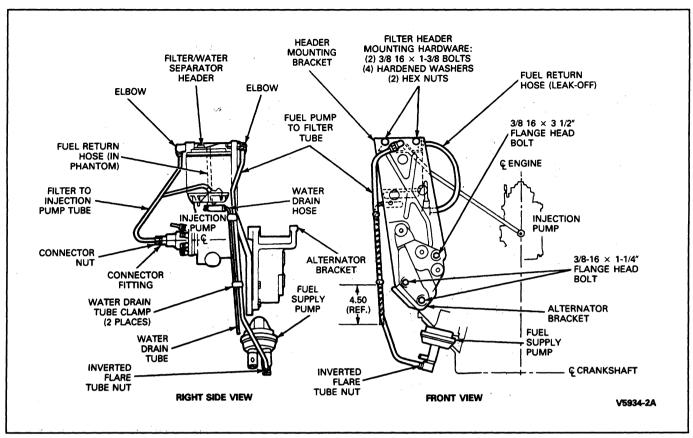
NOTE: Refer to Engine / Emissions Diagnosis Shop Manual for further diagnosis.

If the fuel pump is suspected of being noisy, check for:

- Loose fuel pump mounting bolts. Tighten to 26-37 N·m (19-27 ft-lb), if loose. Replace gasket if damaged or worn.
- Check for loose or missing fuel line attaching clips. This condition will result in the noise being more audible when sitting inside the vehicle than standing outside of it. Tighten clips on fuel lines if necessary.

Before removing a suspect fuel pump:

- Ensure there is adequate fuel in the tank.
- 2. Ensure the fuel filter is not plugged. If it has not been changed recently, install a new filter.
- Inspect all rubber hoses from the fuel pump to fuel tank for kinks or cracks. With engine idling, inspect all fuel lines and rubber hoses and connections from fuel pump to fuel tank for fuel leaks. Tighten loose connections and replace kinked, cracked or leaking fuel lines or hoses as required.
  - NOTE: Leaking lines or hoses and kinked hoses will severely affect fuel pump performance.
- Inspect the fuel pump outlet connection for fuel leaks. Tighten to 20-24 N-m (15-18 ft-lb), if required.
- Inspect the fuel pump diaphragm crimp (the area where the stamped steel section is attached to the casting) and the breather hole(s) in the casting for evidence of fuel or oil leakage. Replace pump if leaking.



To determine if the fuel pump is performing properly, test the fuel pump for capacity (volume) and pressure, with the fuel pump installed on the engine. If the engine is excessively hot, let it cool for 20-30 minutes.

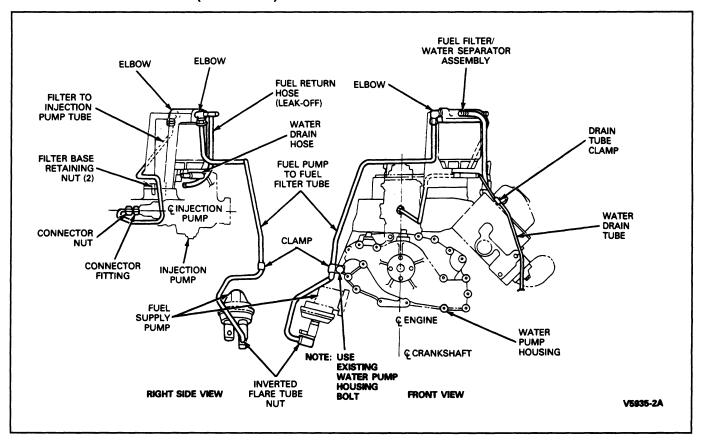
# Capacity (Volume) Test

 Slowly (fuel line is pressurized) disconnect the fuel line at the fuel filter.

# WARNING: USE CARE TO PREVENT COMBUSTION OF SPILLED FUEL.

 Place a suitable non-breakable container (one-half liter or one pint minimum) Rotunda Safety Can 018-00003, or equivalent at the end of the disconnected fuel line (a piece of hose may be needed on the fuel line end). Crank engine ten seconds. The fuel pump should deliver one-third pint of fuel, or more.

- If fuel flow is to specification, perform pressure test.
- 4. If fuel flow is low, repeat test using a remote non-breakable container of diesel fuel. Remove fuel hose from fuel pump inlet supply line. Connect a length of fuel hose from the fuel supply line to the non-breakable container and repeat Step 3. If fuel flow is to specification, the problem is either a plugged fuel / water separator or, a kinked or leaking fuel hose. Service as necessary.
- If fuel flow is below specification, replace fuel pump.



#### **Pressure Tests**

- Connect Rotunda Vacuum and Pressure Tester 059-00008 or equivalent (0-103 kPa or 0-15 psi) to the injection pump end of the fuel line. (No "T" is required.)
- Crank the engine for 10 seconds and read the pressure. Refer to the fuel system specification at the end of this Section for the fuel pressure specification. If pump pressure is too low or too high, install a new fuel pump.
- Connect fuel line.

# **Fuel Valve System**

Refer to the following diagnosis charts for fuel valve system troubleshooting.

For diagnosis of fuel indicating system problems with fuel selector valve, refer to Fuel Gauge, Section 13-03. For the following diagnostic procedure, both tanks must contain some useable fuel.

|    | TEST STEP  | RESULT                        |          | ACTION TO TAKE  |
|----|--|-------------------------------|----------|---|
| A1 | CHECK FOR VOLTAGE  |                               |          |   |
|    | Disconnect electrical connector from tank selector valve.  | Voltage present               |          | GO to A2.   |
|    | Turn ignition to RUN position.   | No voltage present            |          | GO to <b>A5</b> .   |
|    | <ul> <li>Move selector switch to Front position and check for<br/>voltage between connector terminals No. 2 and No.<br/>1.</li> </ul>                                |                               |          |   |
| A2 | CHECK VOLTAGE  |                               |          |   |
|    | Check voltage between terminal No. 2 and ground.   | Voltage present               |          | GO to <b>A3</b> .   |
|    |  | No voltage present            |          | GO to <b>A5</b> .   |
| АЗ | CHECK FUEL VALVE MOTOR   |                               |          |   |
|    | <ul> <li>Jumper motor terminal No. 2 to battery positive and<br/>motor terminal No. 1 to frame ground.</li> </ul>  | Motor runs in both directions |          | GO to A6.   |
|    | Motor should run.  | Motor does not run in         |          | REPLACE motor.  |
|    | <ul> <li>Reverse jumper leads to motor.</li> </ul>   | one or both directions        |          |   |
|    | Motor should run in opposite direction.  |                               |          |   |
| A4 | CHECK GROUND CIRCUIT   |                               |          |   |
|    | <ul> <li>Check for open ground circuit from motor, through<br/>switch to ground.</li> </ul>  | (OK)                          |          | GO to <b>A6</b> .   |
|    |  | <b>Ø</b>                      |          | REPAIR ground circuit.  |
| A5 | CHECK FUSE   |                               |          |   |
|    | Check for voltage across fuse No. 15 (10 Amp) in fuse panel.   | <b>⊗</b>                      |          | GO to <b>A6</b> .   |
|    | •  | <b>(</b>                      |          | REPAIR short(s) in  |
|    |  |                               |          | selector valve circuits as<br>necessary. REPLACE<br>fuse. REPEAT Test Step<br>A1. |
| A6 | CHECK SELECTOR SWITCH CONTINUITY   |                               | $\dashv$ | ni.   |
|    | Remove fuel tank selector switch mounting screws and disconnect switch from harness connector.   | (OK)                          |          | GO to A7.   |
|    | With selector switch in Front (F) position, check for continuity between terminals No. 1 and No. 2 and between terminals No. 4 and No. 5.                            | Ø                             |          | REPLACE fuel selector switch.   |
|    | <ul> <li>Move selector switch in REAR (R) position, and<br/>check continuity between terminals No. 2 and No. 3<br/>and between terminals No. 5 and No. 6.</li> </ul> |                               |          |   |
|    |  |                               |          |   |

| TEST STEP  | RESULT     | ACTION TO TAKE  |
|--|------------|---|
| A7 CHECK CONTINUITY OF CIRCUITS 974 and 674  |            |   |
| Check continuity of circuits 786 (red) and 789 (brown/white) between selector switch and selector valve.   | <b>⊗</b> ► | GO to A8.  REPAIR open circuit(s) as necessary.                                 |
| A8 CHECK FOR FUEL FLOW FROM FRONT TANK   |            |   |
| <ul> <li>Turn ignition to RUN position.</li> <li>Move selector switch to FRONT position and turn ignition OFF.</li> <li>Disconnect the fuel supply line from rear tank to selector valve.</li> <li>Remove vacuum purge valve from fuel filter adapter.</li> <li>Install adapter 3019 from Rotunda Pressure Test Kit 014-00761 or equivalent.</li> <li>Start engine and let idle with no load.</li> <li>Open clamp on sample hose, allowing fuel to flow into a suitable container.</li> <li>Check for solid, continuous flow of fuel.</li> </ul> |            | CONNECT rear supply line. GO to A11. GO to A9.                                  |
| A9 BY-PASS FUEL SELECTOR VALVE   |            |   |
| Disconnect the supply line to the engine at the selector valve.  | <b>⊗</b> ► | REPLACE fuel selector valve.  |
| <ul> <li>Disconnect the supply line from the front tank at the<br/>selector valve.</li> </ul>  | <b>⊗</b> ► | GO to A10.  |
| <ul> <li>Connect the two lines together using a suitable<br/>length of fuel hose equipped with two male<br/>connectors and repeat Test Step A8.</li> </ul>   |            |   |
| 110 CHECK SYSTEM FOR RESTRICTIONS  | _          |   |
| <ul> <li>Check front fuel tank sender, sedimentor, fuel filter<br/>and fuel lines for kinks or restrictions.</li> </ul>  | <b>⊗</b> ► | CHECK fuel tank for sufficient amount of fuel. REPEAT Test Step <b>A8</b> .     |
|  | <b>⊗</b> ► | CLEAN, REPAIR or<br>REPLACE components<br>as necessary. REPEAT<br>Test Step A8. |

• Check for solid, continuous flow of fuel.

|     | TEST STEP  | RESULT    | ACTION TO TAKE  |
|-----|--|-----------|---|
| A11 | CHECK FUEL FLOW FROM REAR TANK   |           |   |
|     | Turn ignition to RUN position.   | (OK) ▶    | Fuel supply system OK.  |
|     | <ul> <li>Move selector switch to REAR position and turn<br/>ignition OFF.</li> </ul>                               |           | CONNECT fuel line to fuel injection pump. CONNECT the front tan |
|     | Disconnect the fuel supply line from front tank to selector valve.   |           | supply line. GO to Test<br>Step <b>B1</b> .                     |
|     | <ul> <li>Remove vacuum purge valve from fuel filter adapter.</li> </ul>  | <b></b> ≥ | GO to A12.  |
|     | <ul> <li>Install adapter 3019 from Rotunda Pressure Test Kit<br/>014-00761, or equivalent, see step A8.</li> </ul> |           |   |
|     | Start engine and let idle with no load.  |           |   |
|     | <ul> <li>Open clamp on sample hose, allowing fuel to flow<br/>into a suitable container.</li> </ul>                |           |   |

CV5048-20

# FUEL SELECTOR VALVE DOES NOT CHANGE TANKS - 7.3L DIESEL WITH DUAL TANKS (Continued)

|     | TEST STEP  | RESULT     | ACTION TO TAKE   |
|-----|--|------------|--|
| A12 | BY-PASS FUEL SELECTOR VALVE  |            |  |
|     | Disconnect the supply line to the engine at the selector valve.  | <b>⊗</b> ► | REPLACE fuel selector valve.   |
|     | <ul> <li>Disconnect the supply line from the rear tank at the<br/>selector valve.</li> </ul>   | <b>⊗</b> ► | GO to <b>A13</b> .   |
|     | <ul> <li>Connect the two lines together using a suitable<br/>length of fuel hose equipped with two male<br/>connectors and repeat Test Step A8.</li> </ul> | -          |  |
| A13 | CHECK SYSTEM FOR RESTRICTIONS  |            |  |
|     | <ul> <li>Check rear fuel tank sender and fuel lines to<br/>selector valve for kinks and restrictions.</li> </ul>   | (OK) ►     | CHECK fuel tank for sufficient amount of fuel. REPEAT Test Step A11.             |
|     |  | <b>⊗</b> ► | CLEAN, REPAIR or<br>REPLACE components<br>as necessary. REPEAT<br>Test Step A11. |

CV4264-2B

|    | TEST STEP   | RESULT      | ACTION TO TAKE  |
|----|---|-------------|---|
| B1 | CHECK FUEL RETURN TO SELECTOR VALVE   |             |   |
|    | Disconnect fuel return line from engine at selector valve and insert line into suitable container.  | (OK)        | TURN engine OFF. CONNECT fuel return line to selector valve.                                    |
|    | Turn ignition to RUN position and move tank selector switch to problem tank.  |             | GO to <b>B2</b> .   |
|    | Start engine and check for a solid, continuous flow of fuel.  | Ø           | CHECK return line for kinks or restrictions. REPAIR or REPLACE as necessary. REPEATest Step B1. |
| B2 | CHECK FUEL RETURN TO TANK   |             |   |
|    | Disconnect fuel return line from the problem tank from selector valve.  | (OK)        | CHECK fuel sender a fuel line to tank for kir   |
|    | <ul> <li>Attach a length of 7.9mm (5/16 inch) diameter hose<br/>to selector valve return port and insert line into<br/>suitable container.</li> </ul> |             | or restrictions. REPAII<br>or REPLACE as<br>necessary. RUN engit<br>and CHECK for smoo          |
|    | <ul> <li>Start engine and check for a solid, continuous flow<br/>of fuel.</li> </ul>  |             | running.  |
|    |   | <b>(</b> A) | REPLACE fuel valve.   |

#### REMOVAL AND INSTALLATION

#### **Fuel Supply Pump**

#### Removal

- Loosen the threaded connection(s) with the proper size wrench (flare nut wrench preferred) and tighten snugly. Do not remove lines at this time. If rubber hose outlet connection is used, go to Step 2.
- Loosen mounting bolts approximately two turns.
   Apply force with hand to loosen fuel pump if gasket is stuck. Rotate the engine, by nudging the starter, until the fuel pump cam lobe is near its low position. The tension on the fuel pump will be greatly reduced at the low cam position.

NOTE: Outlet line is pressurized.

3. Disconnect the fuel pump inlet, outlet and fuel vapor return line, if so equipped.

# WARNING: USE CARE TO PREVENT COMBUSTION OF SPILLED FUEL.

 Remove the fuel pump attaching bolts and remove the pump and gasket. Discard the old gasket.

#### Installation

- Remove all fuel pump gasket material from the engine and the fuel pump if installing the original pump.
- Install the attaching bolts into the fuel pump and install a new gasket on the bolts. Position the fuel pump to the mounting pad. Turn the attaching bolts alternately and evenly and tighten them to 26-37 N·m (19-27 ft-lb).
- Install fuel outlet line. If it is a threaded connection, start fitting by hand to avoid crossthreading. Tighten to 20-24 N·m (15-18 ft-lb).
- Install inlet line. Install hose clamp(s).
  - NOTE: If rubber hoses are cracked, hardened or frayed, replace them with new "gasoline" rubber hose.
- Start engine and observe all connections for fuel leaks for two minutes.
- Stop engine and check all fuel pump fuel line connections for fuel leaks by running a finger under the connections. Check for oil leaks at the fuel pump mounting gasket.

# Fuel Lines and Hoses Push Connect Fittings

Push connect fittings for 7.3L diesel systems have two sizes for 9.5mm (3/8-inch) and 7.9mm (5/16-inch) tubing.

Disconnect all push connect fittings from components (sender, 6-way valve) prior to component removal. The push connect fittings to connect flexible fuel lines to the fuel tank sender often cannot be disconnected until the tank is partially lowered, just before removing the fuel tank completely.

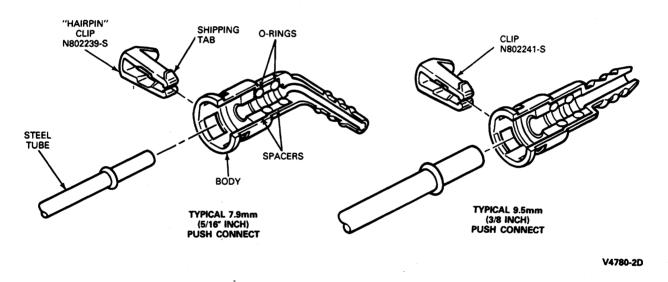
# 7.9mm (5/16-Inch) or 9.5mm (3/8-Inch) Fittings Removal

 Inspect the visible internal portion of fitting for dirt accumulation. If more than a light coating of dust is present, clean the fitting before disassembly.

- Some adhesion between the seals in the fitting and tubing will occur with time. To separate, twist the fitting on the tube, then push and pull the fitting until it moves freely on the tube.
- 3. Remove "hairpin" type clip from fitting by first bending the shipping tab downward so that it will clear the body. Next (using hands only), spread the two clip legs about 3.0mm (1/8 inch) each to disengage the body and push the legs into the fitting. Complete removal is accomplished by lightly pulling from the triangular end of the clip and working it clear of the tube and fitting.

CAUTION: Do not use any tools.

## **Typical Push Connect Fittings**

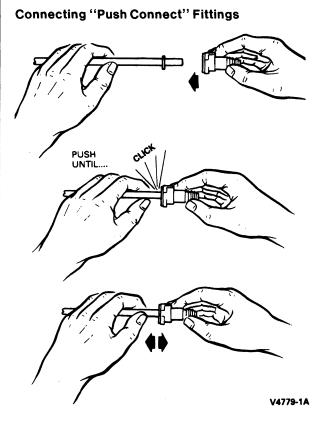


- Grasp the fitting and hose assembly and pull in an axial direction to remove the fitting from the tube.
- 5. When fitting is removed from the tube end, inspect the fitting and tube for any internal parts that may have been dislodged from the fitting. Any loose internal parts should be immediately installed, using the mating tube to insert the parts.

#### Installation

 It is recommended that the original retention clip not be reused in the fitting. To install the new clip, insert clip into any two adjacent openings with the triangular portion pointing away from the fitting opening. Install clip to fully engage the body (legs of "hairpin" clip locked on outside of body). Piloting with an index finger is necessary.

- Before installing the fitting on the tube, wipe tube end with a clean cloth. Inspect the inside of the fitting to ensure it is free of dirt and/or obstructions.
- To install the fitting onto the tube, align the fitting and tube axially and push the fitting onto the tube end. When the fitting is engaged, a definite click will be heard. Pull on fitting to ensure it is fully engaged.



# Fuel Lines—Steel

#### **Engine Compartment**

Fuel supply tubes and the various fuel lines need not be serviced as assemblies. They may be cut, squared and formed out of rolls of fuel system service tubing and hose material available at dealerships, or a service part may be purchased.

A damaged section of tubing longer than 305mm (12 inches) can be cut out of the existing line and replaced by a comparable service tubing section, spliced into the line by means of connecting hoses and retaining clamps. A damaged section of tubing shorter than 305mm (12 inches) can be cut out of the line and replaced by a length of service hose and two retaining clamps.

All replacement hoses must be cut to a length that will ensure proper clamp retention.

#### Removal

 Disconnect the damaged line at both ends. Remove the line from the holding clips along the frame. Remove all damaged hose and tube sections.

## Installation

 Cut a new section of tubing to approximately the same length as the section to be replaced. Allow extra length for flaring the ends of the tubing where required. Square the ends of the cut tubing with a file.

- Ream the inside edges of the cut tubing with the reamer blade on the tube cutter. Be sure metal chips are removed from inside the tube(s). Double flare the ends of the cut tubing, as required.
- Bend the tube section to conform to the contour
  of the original tube. Cut an ample length of hose to
  form a coupling between the ends of the fuel lines.
  Connect the hose couplings to the tubing and
  install the retaining clamps.
- Position the lines in the clips. Connect the lines and check for leaks.

#### Fuel Tubes - Plastic

CAUTION: Ford approved nylon fuel tubing is made from material which has been tested and proven to be acceptable for use with commercially available fuels. It is also resistant to most environmental conditions. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Plastic fuel tube must not be repaired using hose and hose clamps. Push connect fittings cannot be repaired except to replace the retaining clips. Should the plastic tubes, push connect fittings or mating tube ends become damaged and leak, approved service parts must be used to service the fuel lines.

The 7.3L diesel engine uses flexible fuel supply and return lines. These nylon lines replace most of the conventional steel tubing. The plastic fuel tube assemblies are secured to the body rails with clips.

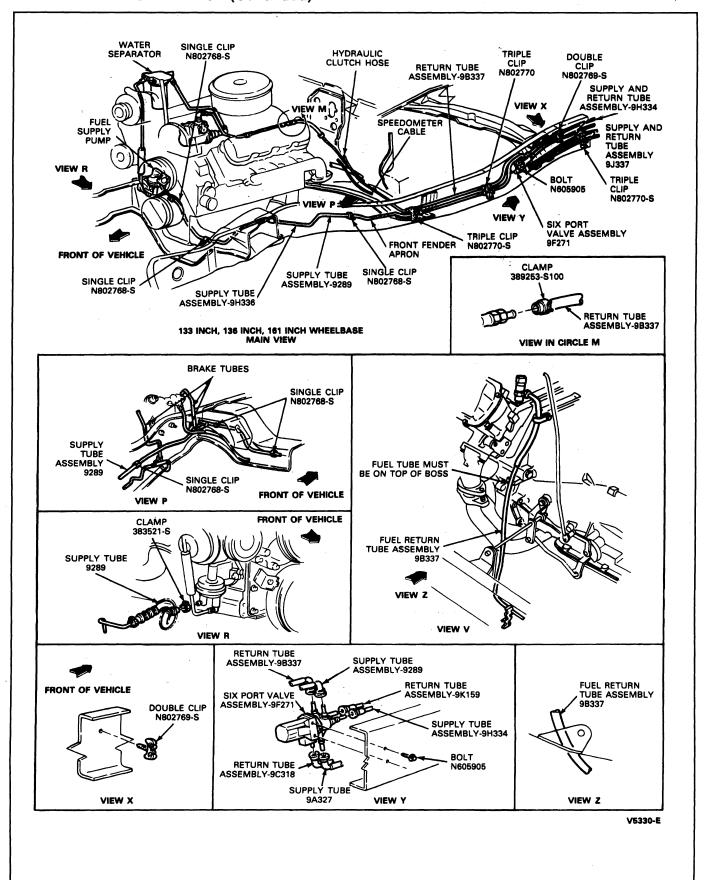
CAUTION: The plastic fuel lines can be damaged by torches, welding sparks, grinding and other operations which involve heat and high temperatures. If any repair or service operation will be used which involves heat and high temperatures, locate all fuel system components, especially the plastic fuel lines to be certain they will not be damaged. It is recommended that the plastic fuel tubes be removed from the vehicle if a torch or high heat producing equipment is to be used for service in the following areas:

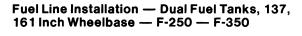
- Exhaust or suspension components in proximity to fuel tubes.
- Underbody frames, rails and crossmembers (LH side).
- Dash panel, under vehicle or inside the passenger compartment (lower LH side).

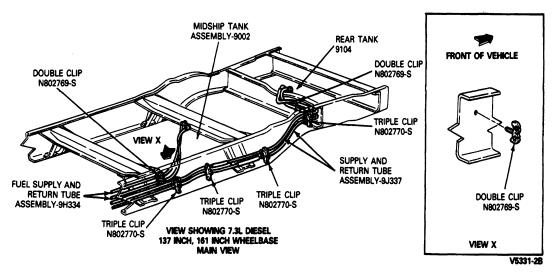
Refer to the following illustrations for fuel line installation.

Fuel Line Installation — Aft Axle Fuel Tank, 133 Inch Wheelbase — F-250 — F-350

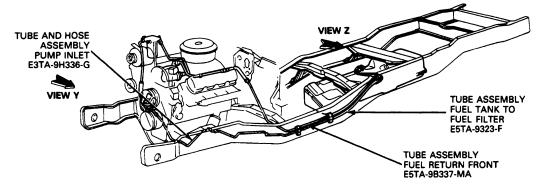
Refer to the following illustration.

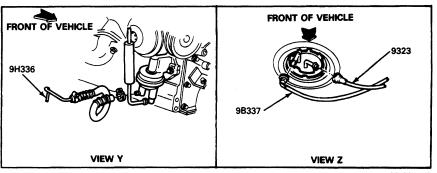




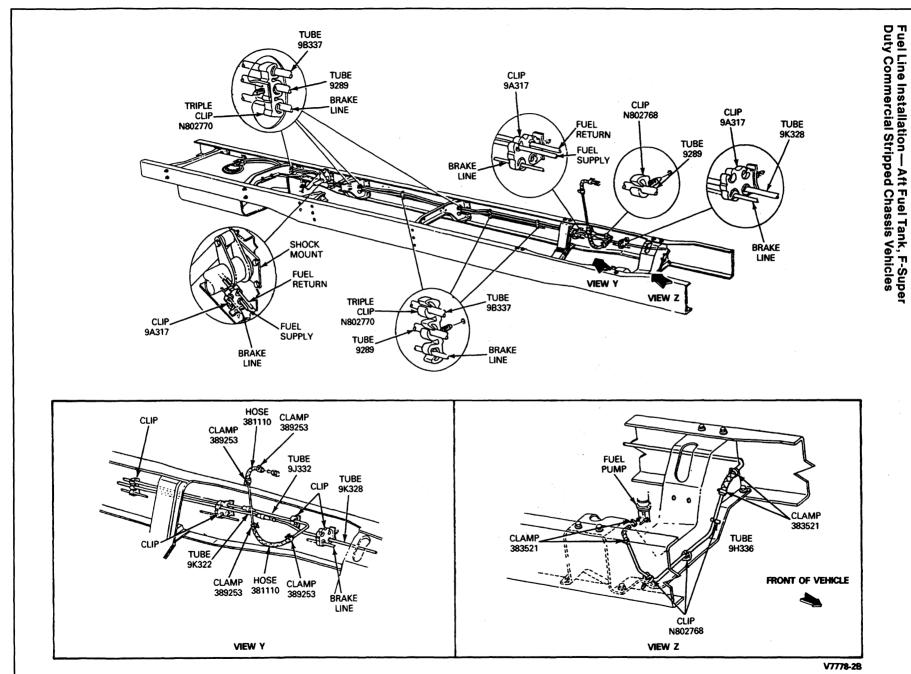


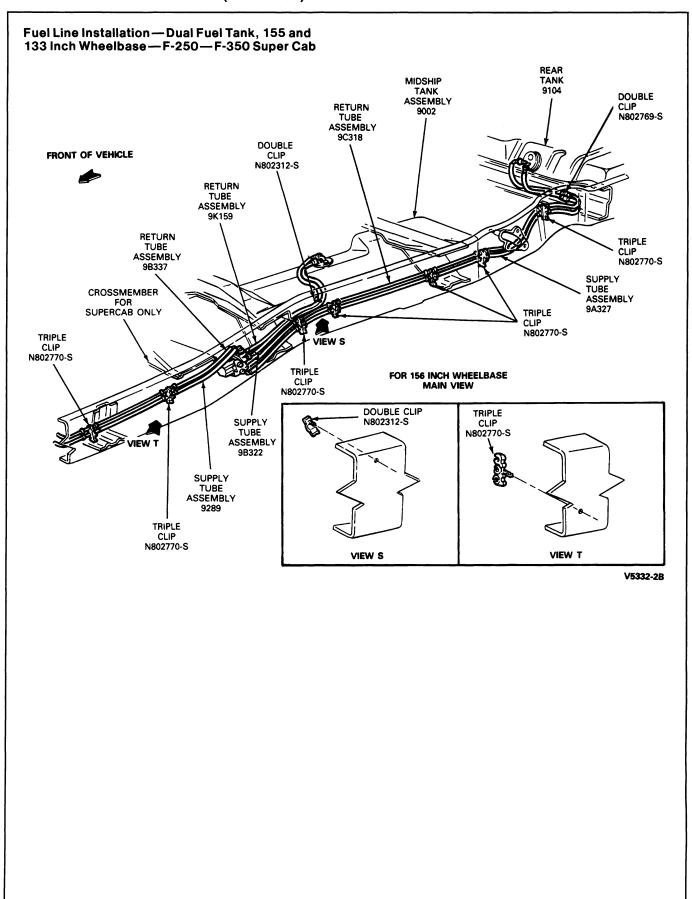
Fuel Line Installation — Midship Fuel Tank, 137, 161 Inch Wheelbase — F-250 — F-350 — F-Super Duty

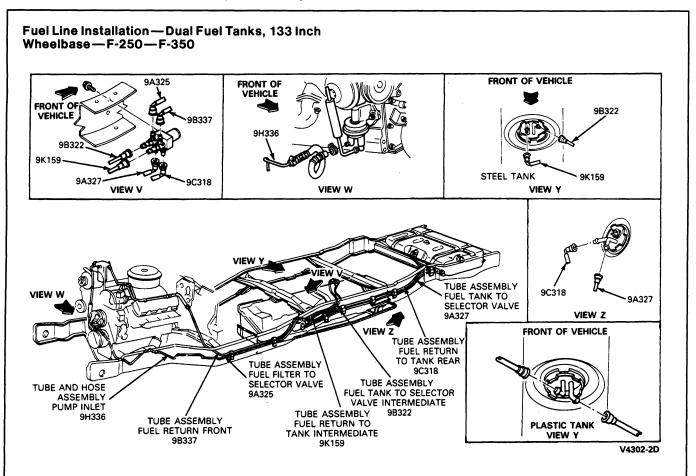


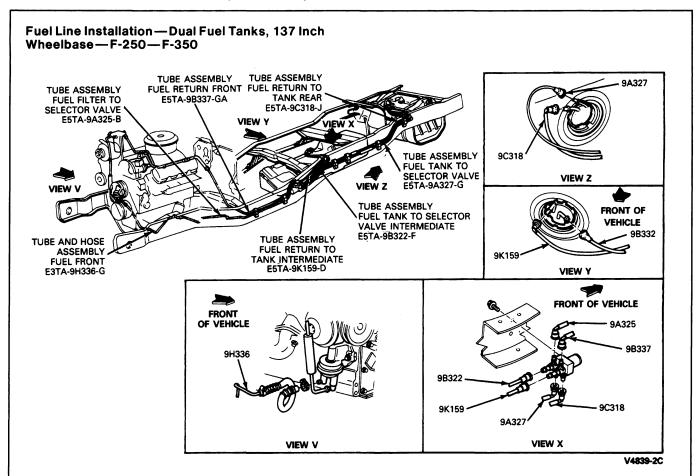


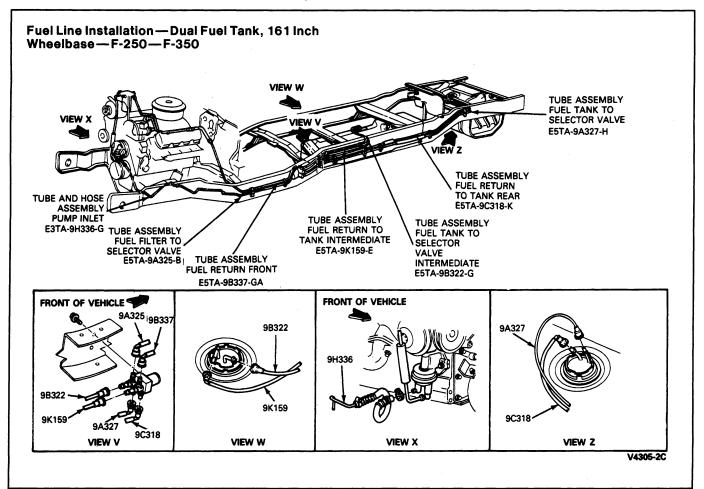
V4835-2C











#### **Fuel Tanks**

# F-250—F-350—F-Super Duty Chassis Cab and Commercial Stripped Chassis

#### Aft-Of-Axle Fuel Tank

Fuel tank installations are shown in the following illustrations.

#### Removal

- Raise the rear of the vehicle.
- To avoid electrical sparking at the tank, disconnect the ground cables on both batteries. Then disconnect the fuel gauge sending unit wire at the fuel tank.
- On vehicles with dual tanks, disconnect the ground wire after both tanks have been drained. Siphon the fuel from the tank into a suitable container at the hose between the fuel pump and the fuel tube.
- If the fuel gauge sending unit is to be removed, turn the unit retaining ring counterclockwise and remove the sending unit, retaining ring and gasket. For F-Super Duty Commercial Stripped Chassis vehicles, remove the 10 attaching screws.

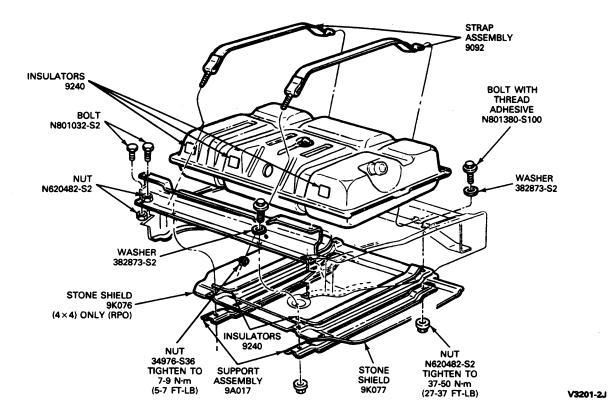
- Loosen the clamp on the fuel filler pipe at the tank and disconnect the filler pipe hose, pulling along the rubber inner tube from filler neck.
- 6. If removing the metal type tank, support the tank and remove the bolts attaching the tank supports to the frame. Carefully lower the tank. Finish removing the filler pipe and filler pipe vent hose if not possible in Step 5. Remove the tank under the vehicle.
- 7. If removing the plastic type tank, support the tank and remove the bolts attaching the combination skid plate and tank support to the frame. Carefully lower the tank. Complete removing the filler pipe if not possible in Step 5. Remove the skid plate and tank from under the vehicle. Disassemble the skid plate from the tank.

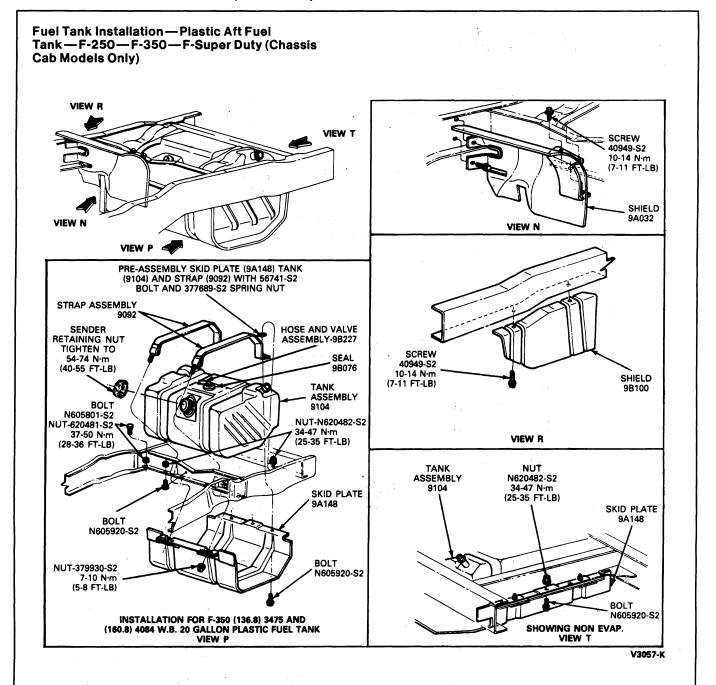
#### Installation

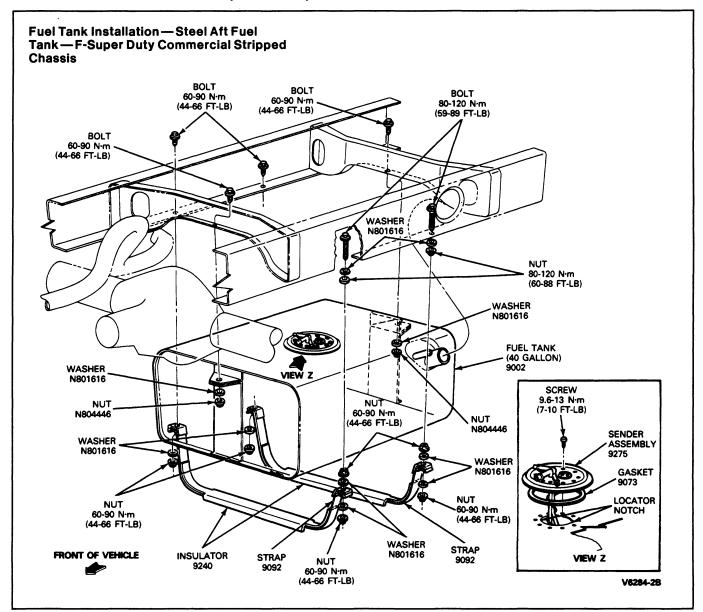
- Install new support strap insulation as required.
- If installing the plastic type tank, preassemble the skid plate and support straps to the tank.
- Raise the tank skid plate and support assembly and start the tank neck into the hose.

- Position the tank assembly against the top straps or the frame and install the attaching bolts and nuts. Tighten the attaching bolts and nuts to 37-50 N·m (27-37 ft-lb).
- Insert rubber inner tube inside filler neck and connect filler pipe hose. Tighten clamp to 3-4 N-m (27-35 in-lb).
- 6. If the fuel gauge sending unit was removed, make sure all the old gasket material has been removed from the unit mounting surface on the tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure with the retaining ring or attaching screws.
- Connect the fuel gauge sending unit wire to the sending unit.
- 8. Connect the fuel line at the fuel gauge sending unit and tighten the clamps securely. Install the drain plug, if so equipped. Fill fuel tank.
- Connect both vehicle battery ground cables.
- 10. Fill the tank and check all connections for leaks.
- 11. Lower the vehicle.

Fuel Tank Installation — Steel Aft Fuel Tank — F-150 — F-350







# Midship Fuel Tank — Plastic

## Removal

- Drain the fuel into a suitable container by siphoning through the fuel hose at the fuel pump-to-fuel tube connection.
- To avoid electrical sparking at the tank, disconnect the ground cables on both batteries.
- 3. Remove skid plate and heat shields.
- Disconnect the fuel gauge sending unit wire at the fuel tank.
- Loosen fuel filler hose clamp at the tank and disconnect the fuel filler hose.
- 6. Disconnect the fuel tube push-connect fittings at fuel gauge sending unit.

- 7. Support the tank. Remove the bolts from the retaining straps and lower the tank to the floor.
- To remove fuel gauge sending unit, rotate threaded retainer ring counterclockwise with Tool (TBD) or equivalent.
- 9. To remove vapor valve, pull it out of the grommet.
- 10. Replace any worn or damaged parts.

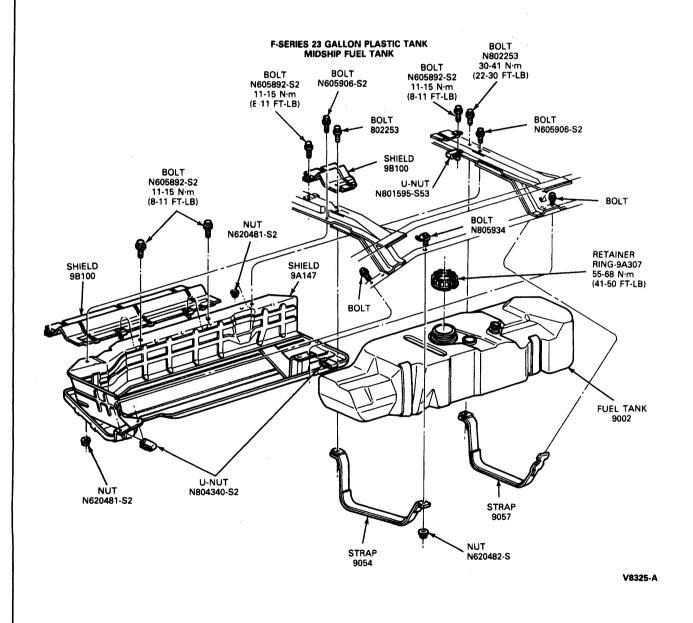
#### Installation

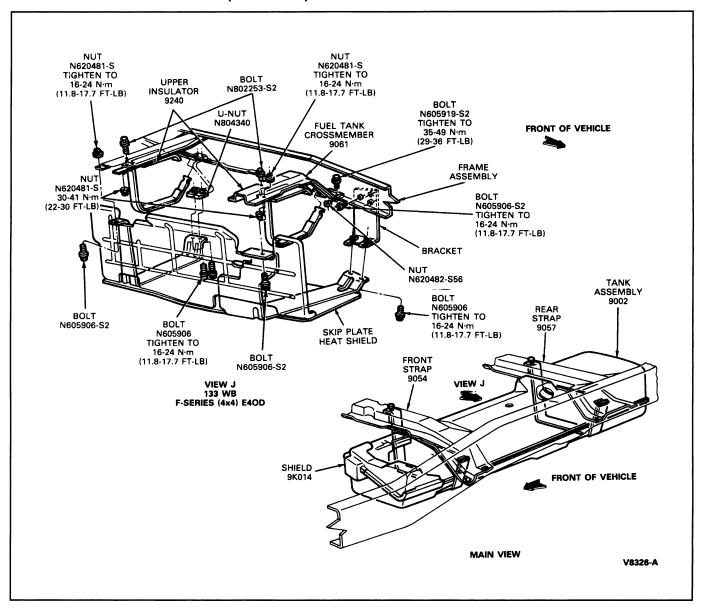
- Position fuel gauge sending unit seal in groove.
  Then, position fuel gauge sending unit in tank and
  install threaded retainer ring with Tool (TBD) or
  equivalent. Tighten to 55-68 N·m (41-50 ft-lb).
- 2. Insert vapor valve into grommet.

- Position tank in vehicle and secure retaining straps to frame with hand-started attaching bolts.
- Position and secure fuel filler hose on fuel tank filler neck. Make sure the inner hose is not twisted or kinked inside tank neck and filler pipe. Tighten hose clamp to 3-4 N·m (27-35 in-lb).
- 5. Clip vapor valve hose to frame rail.
- Connect the fuel tubes and electrical connector to the fuel gauge sender unit.
- 7. Tighten strap attaching bolts to 16-24 N·m (12-18 ft-lb).

- Position heat shield on fuel tank retaining strap studs and tighten attaching nuts to 8-11 N·m (6-8 ft-lb).
- Position skid plate in vehicle and secure the skid plate and heat shield to frame with attaching bolts and nuts. Tighten to 8-11 N·m (6-8 ft-lb).
- Position heat shield in vehicle and secure it to the frame and the heat shield with attaching bolts. Tighten to 8-11 N-m (6-8 ft-lb).
- 11. Connect battery ground cables at both batteries.
- 12. Fill the tank and check all connections for leaks.

#### F-Series 23 Gallon Plastic — Midship Fuel Tank





# Midship Fuel Tank — Steel

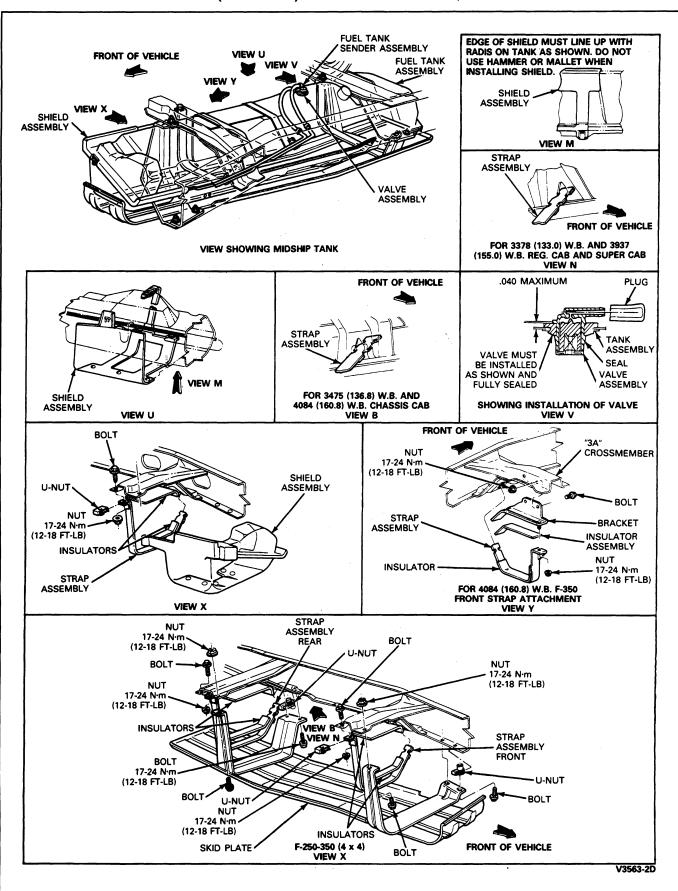
#### Removal

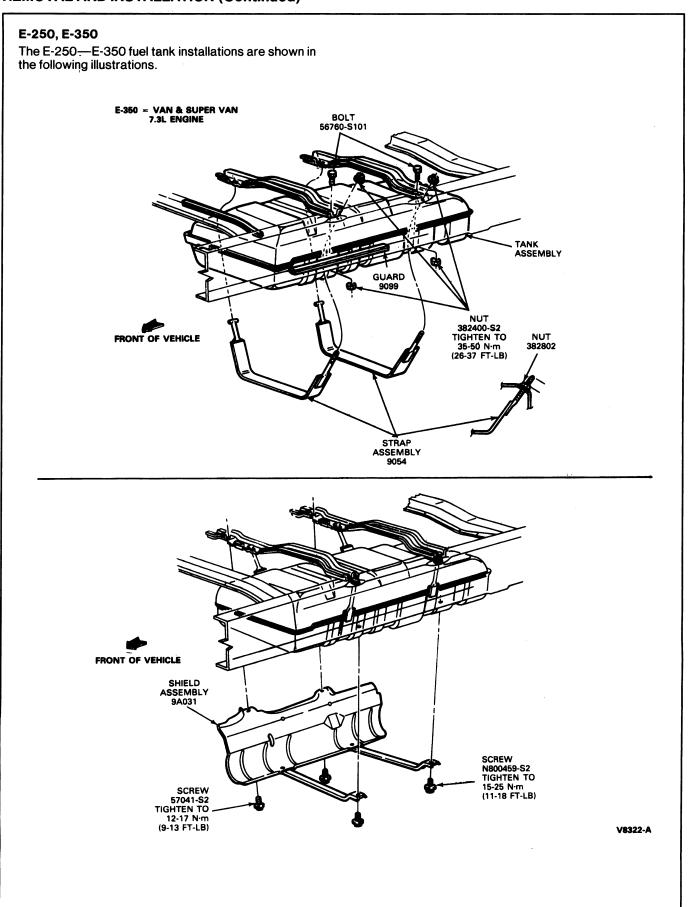
- Drain the fuel into a suitable container by siphoning through the fuel hose at the fuel pump-to-fuel tube connection.
- To avoid electrical sparking at the tank, disconnect the ground cables on both batteries. Then disconnect the fuel gauge sending unit wire at the fuel tank.
- On vehicles with dual tanks, disconnect ground wire after draining both tanks. Remove the clamps and disconnect the hoses attached to the fuel tank.

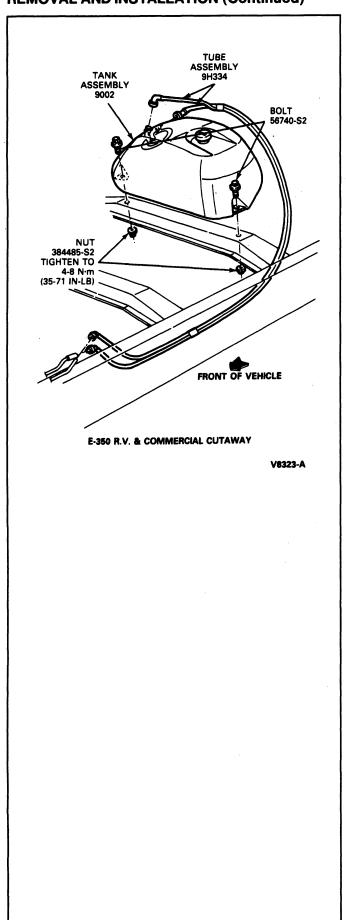
 Support the tank, remove the nuts and bolts from the retaining straps, and lower tank to floor. Replace any worn or damaged parts.

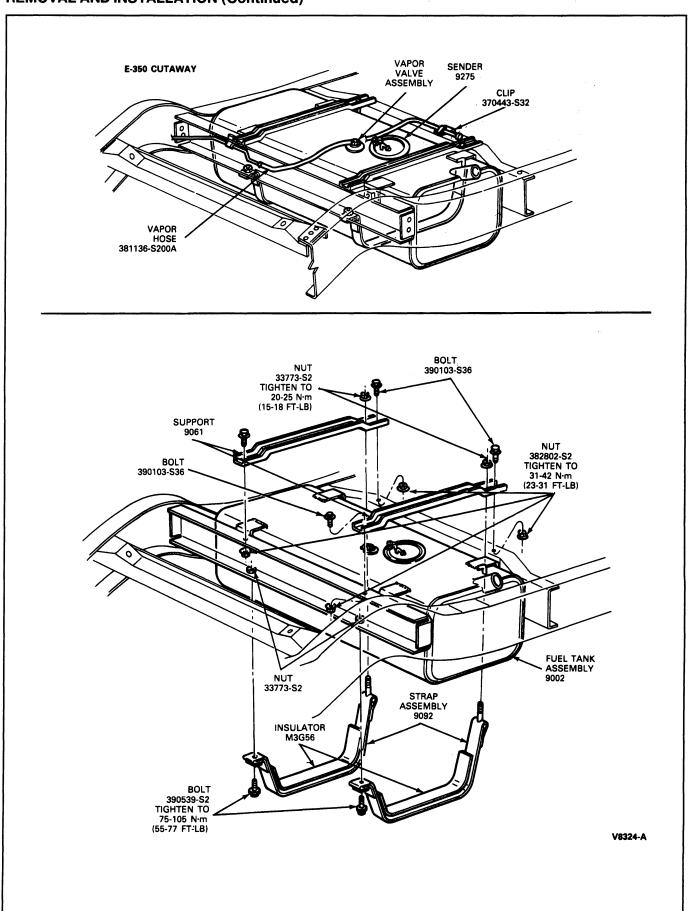
#### Installation

- Position retaining straps around fuel tank and attach bolts and nuts. Tighten to 30-41 N·m (22-30 ft-lb).
- Insert rubber inner tubes inside filler necks and connect hoses to the tank. Make sure the inner tube is not kinked or twisted in filler neck end in filler pipe. Tighten clamps to 3-4 N·m (27-35 in-lb).
- Fill tank with fuel and connect both battery ground cables. Start the engine and check for leaks.









# Aft Axle Body — Mounted Tanks Removal

- Siphon the fuel from the tank by disconnecting the fuel supply line at the selector valve (dual tank vehicles) or at the connection to the steel fuel lines on the left frame rail ahead of the transmission.
- To avoid electrical sparking at the tank, disconnect the ground cable on both vehicle, batteries.
- Raise the vehicle. Then, disconnect the fuel gauge sending unit electrical connector at the fuel tank.
- Loosen the clamps on the fuel filler hose and vent hose at the tank neck. Disconnect the hoses from the tank.
- Disconnect the fuel line push connect fittings as outlined.
- 6. Support the tank in position. Remove the nuts that attach the mounting straps to the "T" bolts.
  - NOTE: The "T" bolts are attached to body brackets (located at the rear of the tank).
  - Disengage the straps from the T-bolts and the front body brackets.
- Lower the fuel tank and remove it from underneath the vehicle.
- If the fuel gauge sending unit is to be removed, turn the unit retaining ring counterclockwise and remove the sending unit retaining ring and gasket.
- If the vapor control valve is to be removed, pull it out of the seal located in the top of the tank and remove the seal.

#### Installation

- If the fuel gauge sending unit was removed, scrape away the old gasket material from the mounting surface on the fuel tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure it with the retaining ring.
- If the vapor control valve was removed, install the seal in the tank opening and press-fit the valve into place.
- Attach the front ends of the mounting straps to the front body brackets.
- Secure the strap ends to the T-bolts with the attaching nuts. Tighten nuts to 42-47mm (1.65-1.85 inches) of exposed thread length.
- Connect the fuel lines to the fuel gauge sending unit as outlined.
- Connect the fuel filler hose to the filler neck and vent neck at the tank. Tighten hose clamps to 3-4 N·m (25-35 in-lb).
- Connect the fuel gauge sending unit electrical connector.

- Lower the vehicle and connect both battery ground cables.
- 9. Fill the tank and check all connections for leaks.

# Aft Axle Frame — Mounted Tank Removal

- Siphon the fuel from the tank by disconnecting the fuel supply line at the connection to the steel fuel lines on the left frame rail ahead of the transmission.
- 2. To avoid electrical sparking at the tank, disconnect both battery ground cables.
- 3. Raise the vehicle.
- Loosen the clamps on the fuel filler hose and vent hose at the tank neck. Disconnect the hoses from the tank.
- Disconnect the fuel line push connect fittings as outlined.
- Support the tank in position. Remove the nuts and bolts that attach the tank supports to the frame. Disengage the straps from the front tank support and the rear crossmember. Lower the tank and remove it from underneath the vehicle.
- 7. If the fuel gauge sending unit is to be removed from the unit, remove the retaining bolts. Remove the sending unit and gasket.
- If the vapor control valve is to be removed, pull it out of the seal located in the top of the tank, and remove the seal.

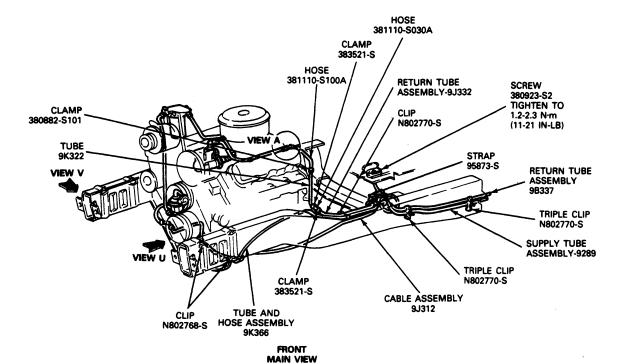
#### Installation

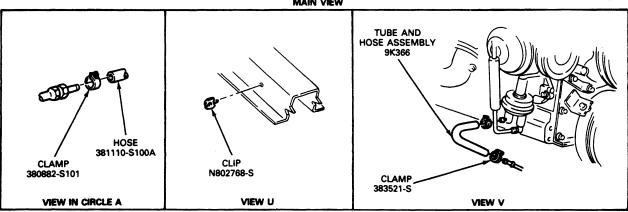
- If the fuel gauge sending unit was removed, scrape away all the old gasket material from the mounting surface on the fuel tank. Using a new gasket, position the fuel gauge sending unit on the fuel tank and secure it with the retaining bolts.
- If the vapor valve was removed, install the seal in the tank opening and press-fit the valve into place.
- 3. Raise the tank and attach the fuel sender electrical connector. Connect the fuel sender to the plastic fuel lines.
- Attach the mounting straps to the crossmember in front of the tank with mounting bolts installed finger-tight.
- Position the tank assembly against the top straps and insert the T-bolts into the rear crossmember. Tighten the T-bolt nuts to 27-34 N·m (20-25 ft-lb). Tighten the front bolts to 102-142 N·m (75-105 ft-lbs).
- Connect the fuel lines to the fuel gauge sending unit extension lines.
- 7. Connect the fuel filler hose to the filler neck and vent neck at the tank. Tighten the hose clamps to 3-4 N·m (25-35 in-lb).

8. Lower the vehicle.

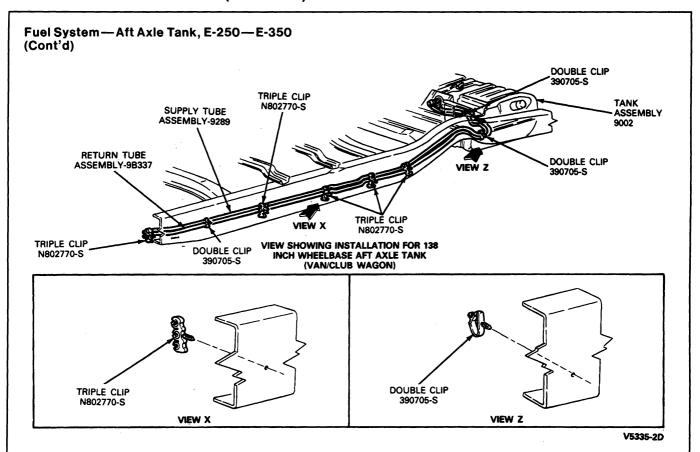
- 10. Fill the tank and check all connections for leaks.
- 9. Connect the vehicle battery ground cable removed in Step 2 of the removal procedure.

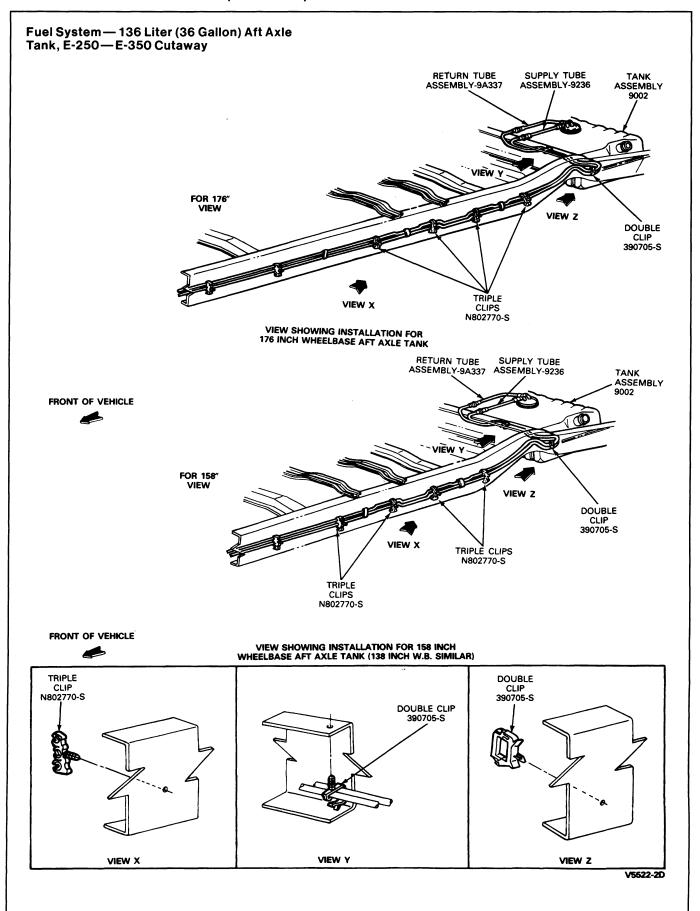
## Fuel System — Aft Axle Tank — E-250 — E-350





V5333-2C





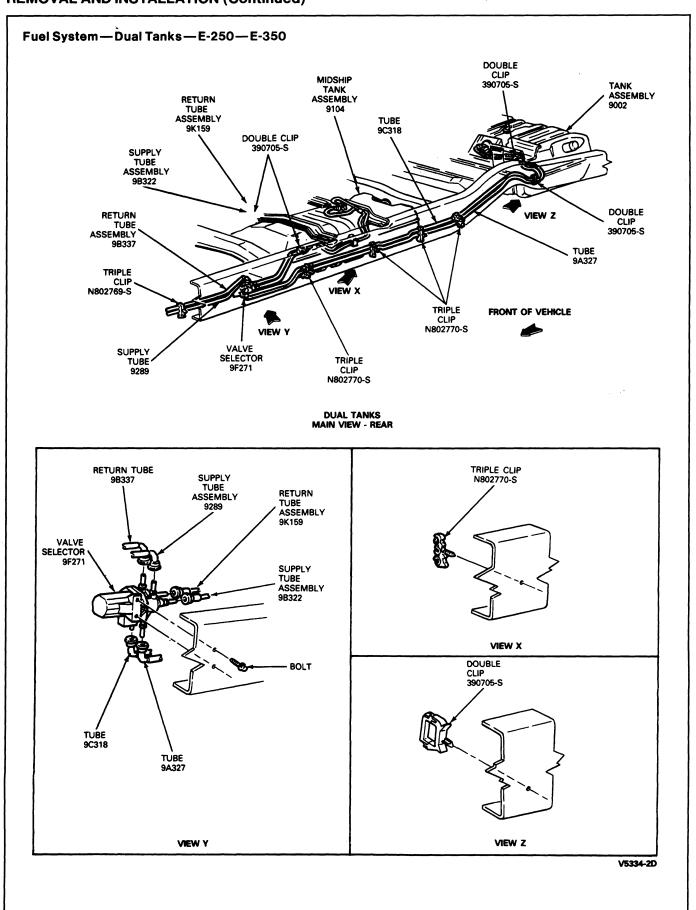
#### Midship Tank

#### Removal

- Siphon the fuel from the tank by disconnecting the fuel supply line at the selector valve.
- To avoid electrical sparking at the tank, disconnect both battery ground cables from both vehicle batteries.
- 3. Raise the vehicle. Then, disconnect the fuel gauge sending unit connector at the fuel tank.
- Support the tank in position. Disengage the mounting strap ends attached to the frame side rail. Remove the other end from the tank support by rotating the strap to disengage the "T" shaped hook end.
- Lower the tank enough to gain access to the fuel fill and vent hoses, and fuel lines. Loosen the fuel fill and vent hoses and disconnect. Disconnect the fuel line push connect fittings as outlined.
- Lower the tank and remove it from underneath the vehicle.
- If the fuel gauge sending unit is to be removed, turn the retaining ring counterclockwise and remove the sending unit, retaining ring and gasket.
- If the vapor control valve is to be removed, pull it out of the seal located on top of the tank and remove the seal.

#### Installation

- If the fuel gauge sending unit was removed, scrape away all the old gasket material from the mounting surface on the fuel tank. Using a new gasket, position the fuel gauge sending unit to the fuel tank and secure it with the retaining ring.
- If the vapor valve was removed, install grommet in the tank opening and press-fit the valve into place.
- If the insulation tape was worn or damaged, remove the material and install new pieces approximately 419mm (16.5 inches) long (two pieces).
- 4. Attach the "T" hook mounting strap ends in the tank supports. Raise the tank high enough and connect the fuel filler hose and fuel vent hose. Attach the plastic fuel lines. Tighten the clamps that attach the fill and vent hoses to the mating tank parts to 3-4 N·m (25-35 lb-in).
- Attach the mounting straps stud end to the frame side rail with attaching nuts. Tighten to 32mm-38mm (1.25-1.50 inch) of exposed stud length.
- Connect the fuel gauge sending unit connector at the fuel tank. Lower the vehicle.
- 7. Connect the vehicle battery ground cables removed in Step 2 of the removal procedure.
- 8. Fill the tank and check all connections for leaks.



#### **Filler Pipes**

# F-250—F-350 — F-Super Duty

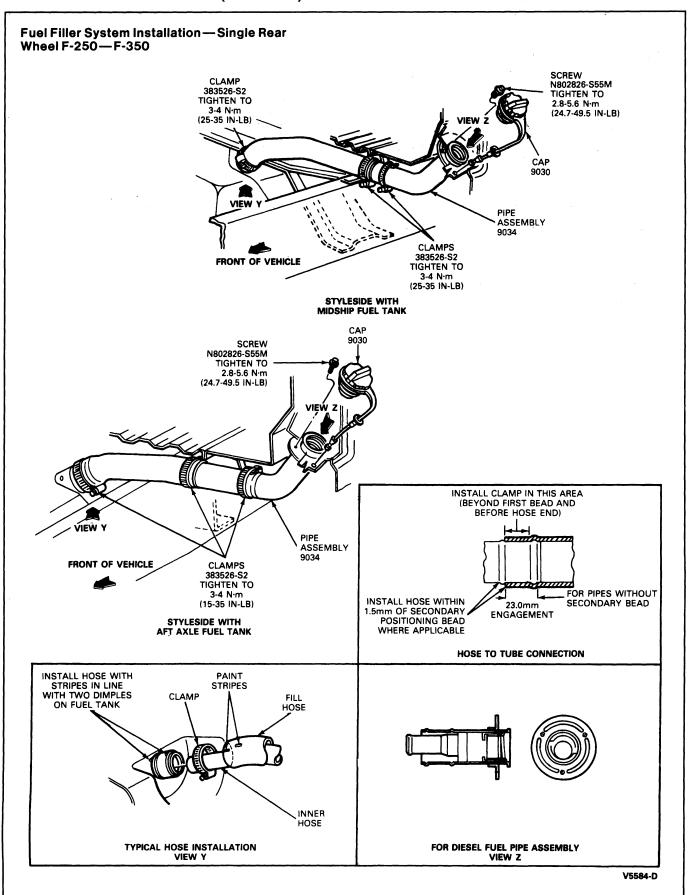
Procedures are the same for aft axle and midship fuel filler pipes.

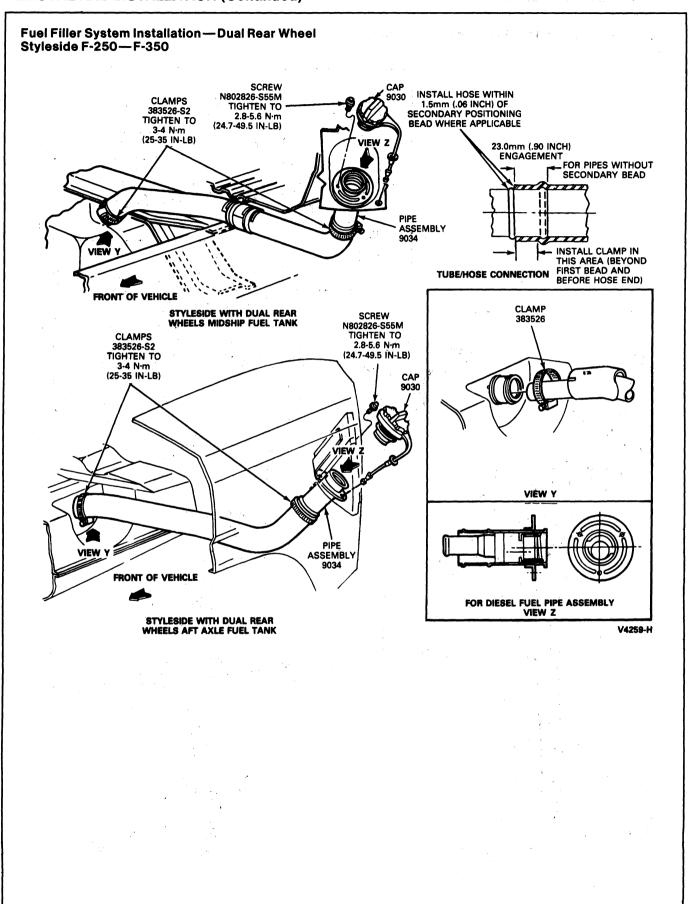
#### Removal

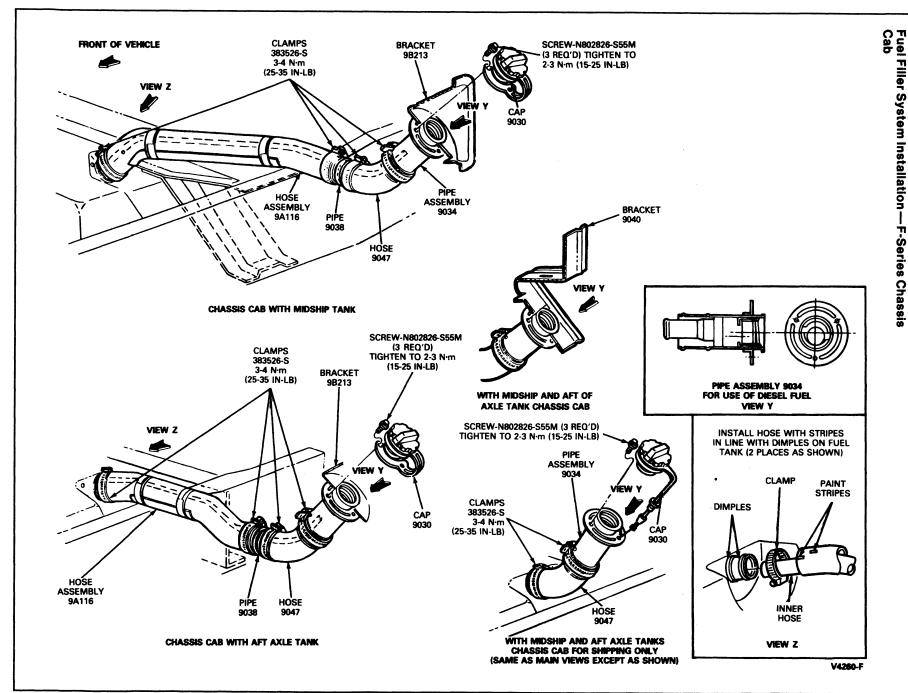
- Drain fuel to a level (approximately 3/4 full) below fuel tank filler connection by using the fuel hose at the fuel pump-to-fuel tube connection.
- Loosen clamp attaching filler pipe hose to fuel tank filler neck. Disconnect filler pipe hose, pulling along rubber inner tube from filler neck.
- Remove three retainer screws that attach filler pipe neck to body fuel filler housing.
- 4. Remove fuel filler pipe from vehicle.
- Remove hose and clamps. Replace all worn or damaged parts.

#### Installation

- 1. Position fuel filler pipe in vehicle.
- Position clamp on filler pipe hose-to-filler pipe neck connection and insert rubber inner tube in filler neck. Make sure that the inner tube is not kinked or twisted in the neck and in the outer filler hose.
- Install three retainer screws attaching filler pipe neck to body fuel filler housing. Tighten to 2-3 N-m (18-25 in-lb).
- Adjust hose to obtain snug filler pipe installation. Tighten hose clamps to 3-4 N·m (25-35 in-lb). Make certain clamps are forward of flange on filler pipe to ensure a leakproof connection.
- Fill tank with fuel. Install filler cap and check for leaks.







#### E-250-E-350

The procedures are the same for both aft axle and midship filler pipe assemblies.

#### Removal

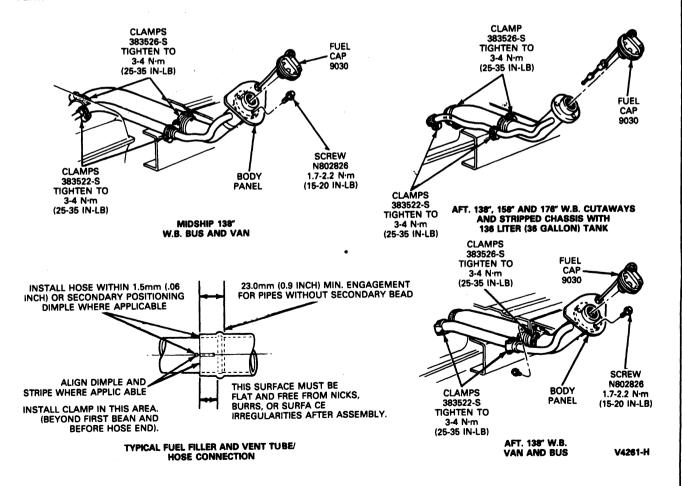
- Siphon the fuel from the tank by disconnecting the fuel supply line at the selector valve (dual tank vehicles) or at the connection to the steel fuel lines on the left frame rail ahead of the transmission.
- Remove the three retainer screws that attach the filler pipe flange to the body fuel filler pipe housing.
- Loosen the clamps that attach the filler pipe to the fuel filler hose and the fuel vent hose.
   Disconnect the hoses.
- Loosen the clamp that attaches the filler pipe to the support bracket at the underbody flange (if present).

Fuel Filler System Installation — E-250 — E-350 (Midship and Aft Tank) and F-Super Duty Commercial Stripped Chassis with 40 Gallon Tank

Remove the fuel filler pipe assembly by rotating it through the opening in the underbody below the body housing assembly.

#### Installation

- Install the fuel filler pipe assembly by inserting it through the underbody opening and rotating it to butt the pipe flange against the body side panel bracket.
- 2. Attach the pipe flange to the body side panel bracket with three retaining screws. Tighten screws to 3-4 N-m (25-35 in-lb).
- 3. Tighten the clamps that attach the filler pipe to the support bracket at the underbody flange to 3-4 N·m (25-35 in-lb.) (if present).
- Connect the fuel filler hose and the fuel vent hose to the fuel filler assembly. Tighten the attaching clamps to 3-4 N-m (25-35 in-lb).
- Fill the tank, install fuel filler cap and check all connections for leaks.



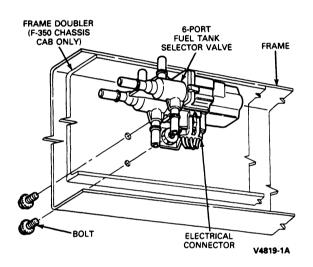
#### Selector Valve—Auxiliary Fuel Tank F-250—F-350 and E-250—E-350

#### Removal and Installation

- Remove the fuel lines from the valve as outlined.
- 2. Remove electrical connector.
- Remove the two bolts mounting the selector valve.
- 4. To install, reverse Steps 1, 2 and 3.

  NOTE: Ensure mounting bolts are tightened to 20-27 N·m (15-20 ft-lb).

#### Fuel Tank Selector Valve — Typical



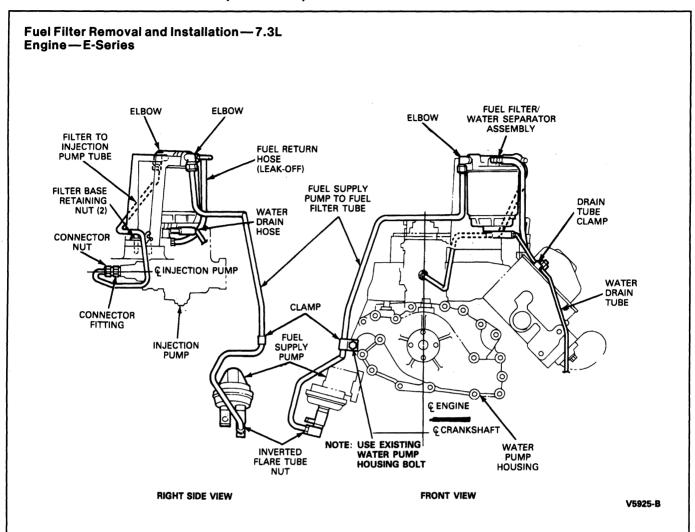
#### **Fuel Filter**

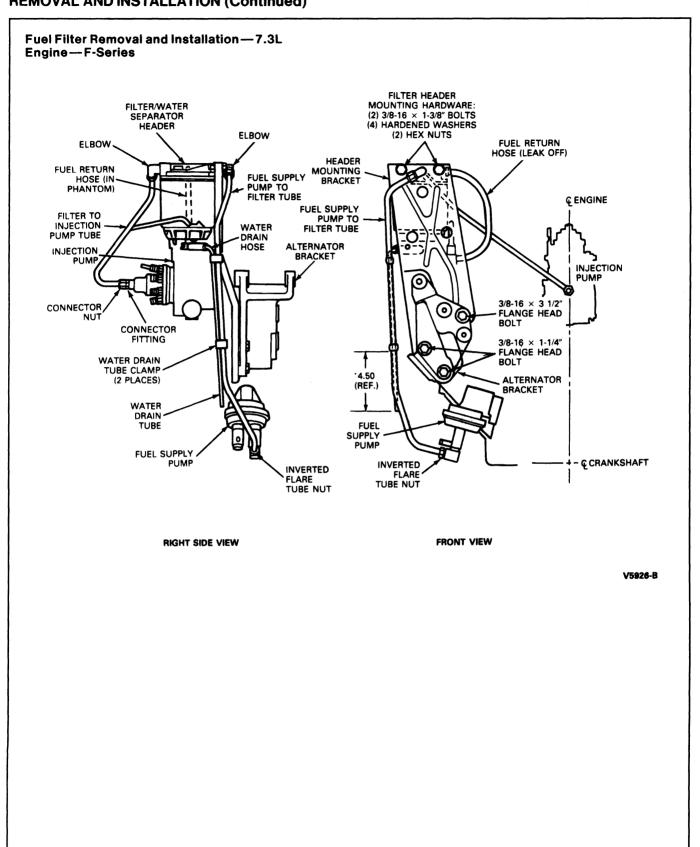
#### Removal

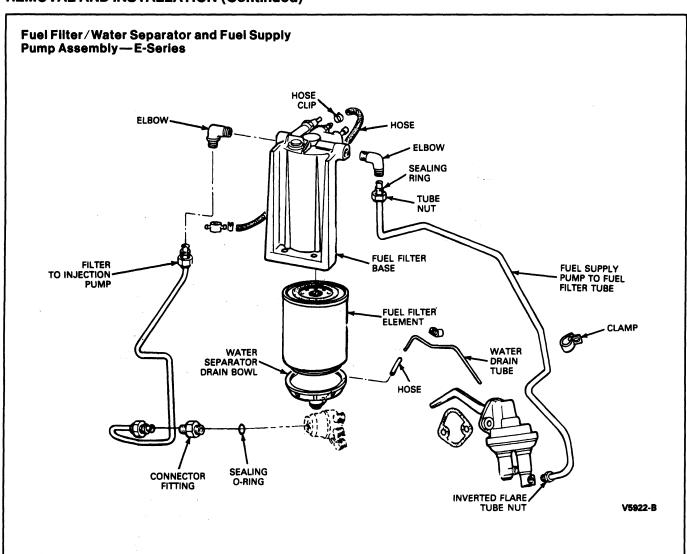
- Disconnect battery ground cables from both batteries.
- Place a container under vehicle and drain fuel from fuel filter.
- 3. Remove water drain tube from bottom of filter assembly.
- 4. Unscrew water separator drain bowl and remove.
- Unscrew fuel filter element and discard.

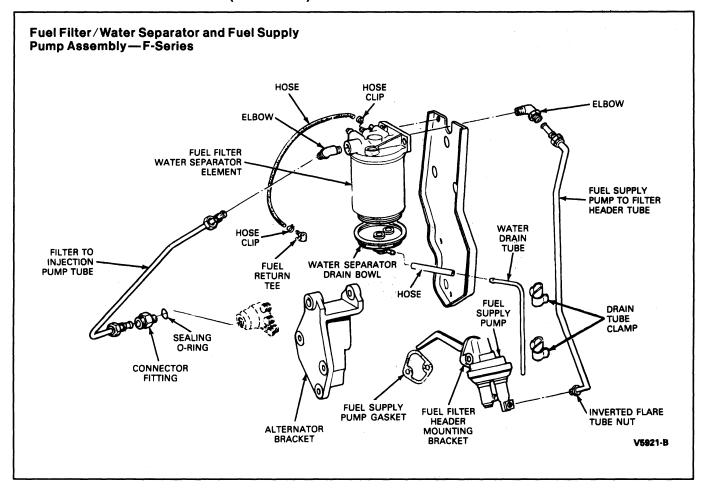
#### Installation

- Clean gasket surfaces of the fuel filter adapter to prevent contamination.
- Lightly coat filter sealing gaskets with clean diesel fuel.
  - NOTE: To avoid fuel contamination, do not add fuel directly to new filter. Allow engine to draw fuel through filter.
- 3. Screw new filter element onto filter base until seal contacts flange.
- 4. Tighten filter another 180 to 300 degree turn.
- Screw on water separator drain bowl. Tighten another 180 to 300-degree turn.
- 6. Install water drain tube.
- 7. Clean up any spilled fuel from top of engine.
- 8. Connect battery ground cables to both batteries.
- 9. Run engine and check for fuel leaks.









#### Major Service Operations Fuel Tanks

Fuel tanks do not require special service procedures and may be steam-cleaned and/or serviced using standard procedures. After steaming, allow them to thoroughly air dry. The vapor separator assembly should be replaced. Replace fuel tank strap bolts. Remove fuel sending unit when cleaning tank.

#### **Fuel Lines**

Vehicles equipped with nylon fuel tubes and push connect fittings have three types of service that can be performed on the fuel lines: replacing nylon tubing (splicing nylon to nylon), replacing push connector fittings, and replacing damaged push connect tube end.

#### **Splicing Nylon to Nylon**

- Cut out damaged section of tubing and retain as a guide.
- Cut a section of service tubing (type 11 or 12 nylon available in 9.5mm (3/8 inch), 7.9mm (5/16 inch) sizes to the same length as the damaged section of tubing.

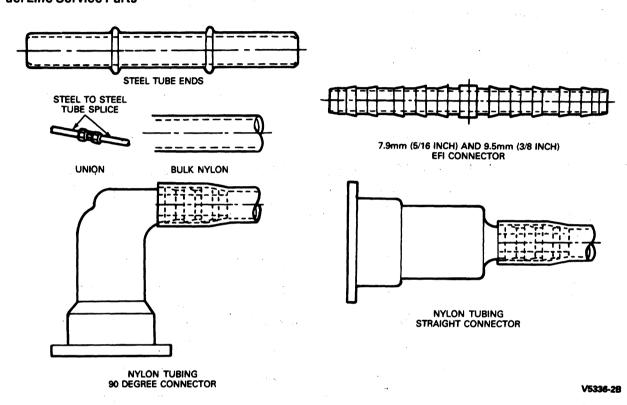
- Select the proper 9.5mm (3/8 inch), 7.9mm (5/16 inch), barbed connectors for completing the splice. Two connectors are required for each splice.
  - NOTE: The connectors may be easily inserted into the nylon lines using Plastic Fuel Line Connector Tool 134-00001 or equivalent.
- Install the barbed connectors into each end of the replacement tubing using Tool 134-00001 or equivalent.
- Install clips onto any tubes which might be difficult to access once the final splices are completed.
- 6. Complete the splice of the replacement nylon to the original nylon tubing at both ends.
- Install any remaining clips which were removed for this service and check that the tubes are secure in the original clips.
- Start engine and check for leaks.

#### **Replacing Damaged Push Connectors**

NOTE: Damaged push connectors must be discarded and replaced with new push connectors. If only the retaining clip is damaged, replace the clip.

- Disconnect the damaged push connector. Be sure to bend the shipping tab to the side before removing retaining clip.
- Select the proper size replacement push connector and nylon tube assembly. In some cases the connectors will not be available with a tube attached. In this event, bulk tubing can be attached to the connector barbed and using the Rotunda Tool 134-00001 mentioned below.

#### **Fuel Line Service Parts**

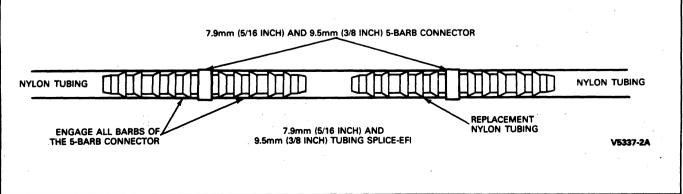


- Cut out a section of the original nylon tube to the same length as the nylon tube attached to the new push connector.
- Install proper barbed connector into the replacement nylon assembly.

NOTE: The connectors may be easily inserted into the nylon lines using Plastic Fuel Line Connector Tool 134-00001 or equivalent.

- 5. Complete the splice by connecting the barbed connector to the original nylon.
- Connect the new connector assembly to the mating tube end.
- Check that the underbody clips are properly securing the fuel tubes.
- 8. Start engine and check for fuel leaks.

#### **Splicing Service**



### Replacing Damaged Steel Push Connect Tube Ends

- Using a tube cutter, remove the damaged push connect tube end at a convenient distance from the end.
  - NOTE: Allow for adequate room to tighten a union with a wrench at this location.
- Choose a proper replacement push connect tube end.
- If required, form the new tube end to the same shape as the damaged tube end which was removed.

- Select the proper size union and attach the new steel tube end to the original tube.
- Clean off the steel tube end and replace the push connector onto the tube. (A new retainer clip is recommended.)
- Check that the underbody clips are properly securing the fuel tubes.
- 7. Start engine and check for leaks.

#### **SPECIFICATIONS**

STANDARD AND AUXILIARY DIESEL FUEL TANKS — CAPACITY IN LITERS (GALLONS)

| Model                                       |  | 1                        |                       | Advertised                       |
|---|--|--------------------------|-----------------------|----------------------------------|
| Series                                      | W. B. MM (in)                          | Body Style               | Location              | Tank Cap. Refil<br>Liters (Gal.) |
| E-350 Cutaway &<br>Stripped Chassis®        | 3505 (138)<br>4013 (158)<br>4470 (176) | Ali                      | Aft/Axle              | 136 (36)                         |
| E-250, 350, Super Van<br>E-350 Super Wagon  | 3505 (138)                             | All                      | Aft/Axle<br>Midship②  | 83 (22)<br>61 (16)               |
| F-250 (4x2)                                 | 3378 (133.0)                           | Reg. Cab                 | Midship<br>Aft/Axle   | 72 (19)<br>69 (18.2)             |
|   | 3526 (138.8)                           | Super Cab                | Midship<br>Aft/Axle   | 62 (16.4)<br>69 (18.2)           |
|   | 3937 (155.0)                           | Super Cab                | Midship<br>Aft/Axle   | 72 (19)<br>69 (18.2)             |
| (4x4)                                       | 3378 (133.0)<br>w/o E 4OD              | Reg. Cab/<br>Cab Chassis | Midship①<br>Aft/Axle① | 72 (19)<br>69 (18.2)             |
|   | 3937 (155.0)                           | Super Cab                | Midship①<br>Aft/Axle① | 72 (19)<br>69 (18.2)             |
| F-350 (4x2) and (4x4)                       | 3378 (133.0)⑥                          | Reg. Cab/<br>Cab Chassis | Midship<br>Aft/Axle   | 72 (19)<br>69 (18.2)             |
| F-Super Duty (4x2)                          | 3475 (136.8)                           | Cab Chassis/<br>FSD      | Midship<br>Aft/Axle③④ | 72 (19)<br>72 (19)               |
|   | 4084 (160.8)                           | Cab Chassis/<br>FSD      | Midship<br>Aft/Axle③④ | 72 (19)<br>72 (19)               |
|   | 3937 (155.0)                           | Crew Cab                 | Midship<br>Aft/Axle②  | 72 (19)<br>72 (19)               |
| F-250-350 (4x4)<br>WE4OD                    | 3378 (133.0)                           | Reg. Cab/<br>Cab Chassis | Midship⑦<br>Aft/Axle  | 87 (23.0)<br>69 (18.2)           |
| F-Super Duty<br>Commercial Stripped Chassis | 4013 (158.0)                           | Stripped Chassis         | Aft/Axle              | 151 (40)                         |

- ① W/R.P.O. Skid Plate
- ② Steel Auxiliary Tank③ Plastic Auxiliary
- Standard Skid Plate
- (§) 15 Liters (4 Gal.) Throwaway Standard on RV Chassis/RV Cutaway and Commercial Cutaway.
- (4x4) W/O E 4OD and All (4x2)

Plastic Tank

CV4267-H

| Engine      | Static Pressure | Mounting Boits | Fuel Lines to Pump |
|-------------|-----------------|----------------|--------------------|
| Liter (CID) | kPa (PSI)①      | N-m (Ft-Lb)    | N·m (Ft-Lb)        |
| 7.3L (445)  | 41-55 (6-8)     | 26-37 (19-27)  | 20-24 (15-18)      |

① On engine with temperatures normalized and at normal curb idle speed, transmission neutral.

CV5514-2B

#### **SPECIAL SERVICE TOOLS**

#### **SPECIAL SERVICE TOOLS**

| Tool         | Description                          |
|--------------|--------------------------------------|
| T63P-9171-A  | Keystone Clamp Pliers                |
| T74P-9275-A  | Fuel Tank Sender Wrench              |
| D87L-9280-A  | Spring-Lock Coupling Tool - 3/8 inch |
| D87L-9280-B  | Spring-Lock Coupling Tool - 1/2 inch |
| T83P-19623-C | Spring Lock Coupling Tool - 5/8 inch |

CV5936-B

#### ROTUNDA EQUIPMENT

| Model     | Description                |
|-----------|----------------------------|
| 059-00008 | Vacuum and Pressure Tester |
| 018-00003 | Safety Can                 |

CV2454-1E

#### ROTUNDA EQUIPMENT

| Tool      | Description                      |
|-----------|----------------------------------|
| 014-00761 | Vacuum/Pressure Tester           |
| 034-00002 | Fuel Storage Tanker              |
| 034-00006 | Suction Pump                     |
| 134-00001 | Plastic Fuel Line Connector Tool |

CV5937-1B

## **SECTION 10-02 Throttle Linkage**

| SUBJECT PAGE                                | SUBJECT P                                   | AGE  |
|---|---|------|
| ADJUSTMENTS                                 | REMOVAL AND INSTALLATION                    |      |
| Non-Automatic Overdrive Transmission10-02-1 | Throttle Linkage — 5.0L EFI and 5.8L EFI    |      |
| Throttle Valve (TV) Control Linkage System  | Engines10-                                  | 02-7 |
| Automatic Overdrive Transmission            | Throttle Linkage — 7.3L Diesel Engine10-0   | 2-10 |
| DIAGNOSIS10-02-2                            | Throttle Linkage — Except 5.0L EFI, 5.8 EFI |      |
|   | and Diesel Engines10-                       | 02-2 |
|   | VEHICLE APPLICATION10-                      |      |
|   |   |      |

#### **VEHICLE APPLICATION**

All Vehicles

#### **ADJUSTMENTS**

#### **Non-Automatic Overdrive Transmission**

Instructions for adjusting throttle linkages used on all gasoline-engine and diesel-engine trucks are contained in the illustrations. Refer to the appropriate illustration for procedures.

Whenever possible, the engine should be at operating temperature when throttle linkage adjustments are made.

CAUTION: Throttle return springs must be installed as indicated in the illustrations and instructions in order to ensure proper accelerator return. After adjustment, ensure that accelerator returns to idle on slow release of foot pressure, without binding or dragging.

## Throttle Valve (TV) Control Linkage System Automatic Overdrive Transmission

Refer to Section 07-01C, Transmission Automatic Overdrive for adjustment procedure.

#### **DIAGNOSIS**

#### ACCELERATOR PEDAL TO THROTTLE BODY Accelerator pedal is hard to push • Disconnect cable end from ball stud at throttle body ensuring the disconnected end of the cable or its spring does not come into contact down or has a rough/raspy or sticky feel. with any of the surrounding parts. • Operate the pedal by hand, observing and feeling that the full pedal range of travel is not restricted by the dash panel insulator or carpet/mat/ padding. If full pedal travel to WOT is restricted, adjust insulator and/or trim items as required. • Operate the pedal by foot. • If cable operation is smooth, refer to the throttle body diagnosis procedures in the appropriate section in the Engine/Émissions Diagnosis Manual, Vol. H\*. • If the condition reoccurs (being sure disconnected end of cable has not come into contact with anything), check the foot pedal assembly for free operation. If the pedal operation is free, replace the cable. • High engine idle speed. • If the cable ball socket extends beyond the throttle lever ball stud, refer to the throttle body diagnosis procedures in the appropriate section in the Engine/Emissions Diagnosis Manual, Vol. H\*. • If the socket does not extend beyond the stud, check the foot pedal assembly for free operation (free from carpet, mats, wiring, etc. contact). If the pedal operation is free, replace the cable. NOTE: Accelerator cable should not be lubricated and it is not serviceable.

#### **REMOVAL AND INSTALLATION**

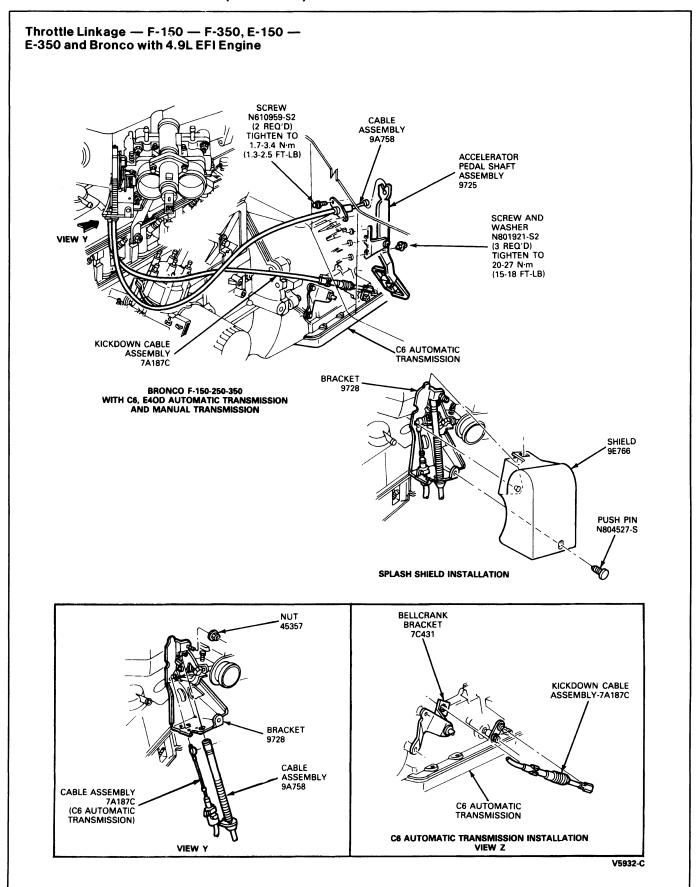
\*Can be purchased as a separate item.

## Throttle Linkage — Except 5.0L EFI, 5.8 EFI and Diesel Engines

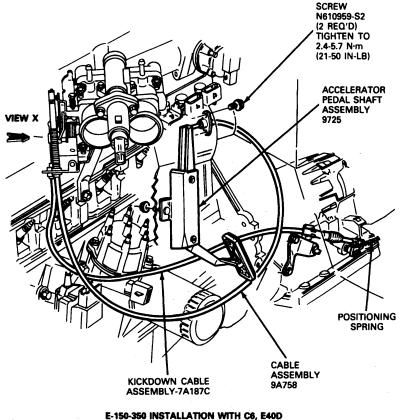
Linkage disconnect points are shown in the illustrations. Installation specifications of major parts are also given.

Be sure to install throttle return springs as shown on the illustrations.

CV4247-2E



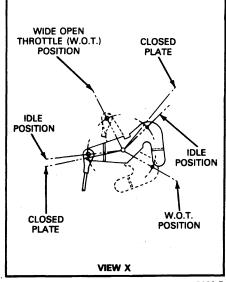
Throttle Linkage — F-250 — F-350 and E-150 — E-350 with 4.9L EFI Engine (Cont.)



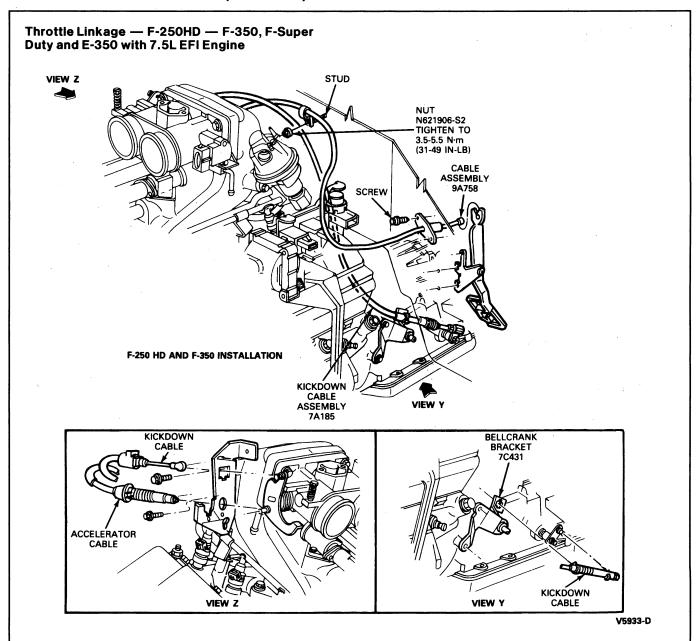
**AUTOMATIC TRANSMISSION** 

### C6 AUTOMATIC TRANSMISSION KICKDOWN CABLE INSTALLATION AND ADJUSTMENT

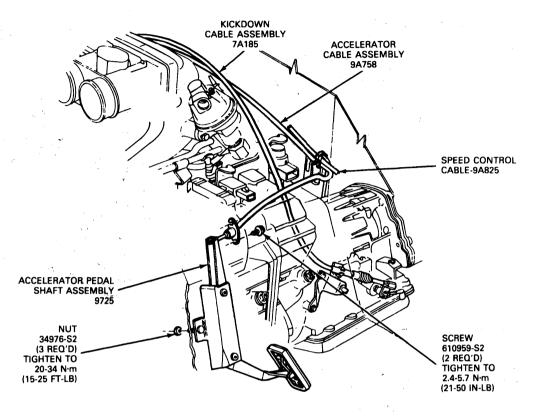
- 1. SELECT KICKDOWN CABLE, INSERT CONDUIT HTTING INTO ENGINE BRACKET AND SLIDE CABLE END FITTING ONTO NAILHEAD STUD ON THROTTLE LEVER. ENSURE THAT THROWAWAY RED SPACER IS SECURED ON CABLE END FITTING. IF SPACER IS MISSING, REUSE A DISCARDED ONE.
- 2. ROUTE CABLE DOWN TO TRANSMISSION AND INSERT CONDUIT FITTING INTO BRACKET, THEN SNAP CABLE END ONTO BALL STUD ON TRANSMISSION LEVER.
- 3. RATCHET CABLE ADJUSTING MECHANISM TO CORRECT SETTING BY ROTATING TO WIDE OPEN THROTTLE POSITION, WITH TOOL NO. 52F-23415 OR BY HAND. REMOVE RED SPACER.



V5623-D

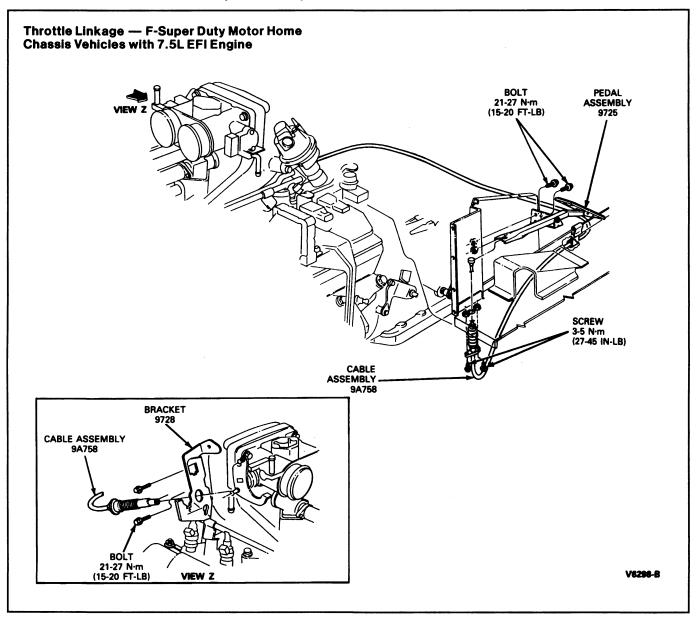


Throttle Linkage — F-250HD — F-350, F-Super Duty and E-350 with 7.5L EFI Engine



E-350 INSTALLATION SAME AS F-250 HD AND F-350 INSTALLATION EXCEPT AS SHOWN

V5624-D



## Throttle Linkage — 5.0L EFI and 5.8L EFI Engines

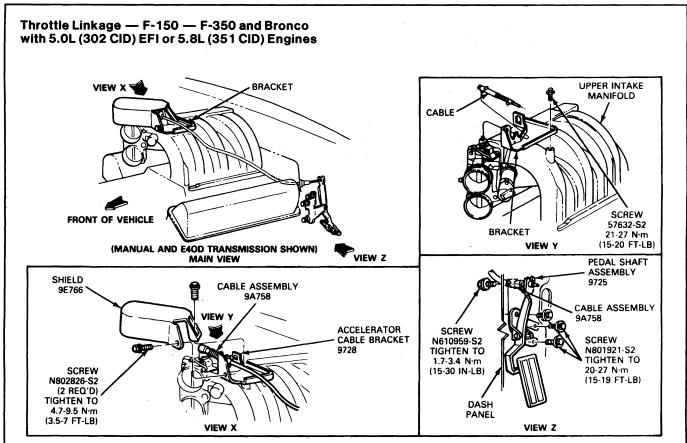
#### Removal

- Remove cable from pedal shaft.
- 2. Remove cable from dash panel.
- For F-series vehicles, remove the two screws retaining shield to the accelerator cable bracket. Remove the shield.
- 4. Remove cable from mounting bracket.
- 5. Remove cable from ball stud.
- Remove three screws retaining pedal shaft to dash.

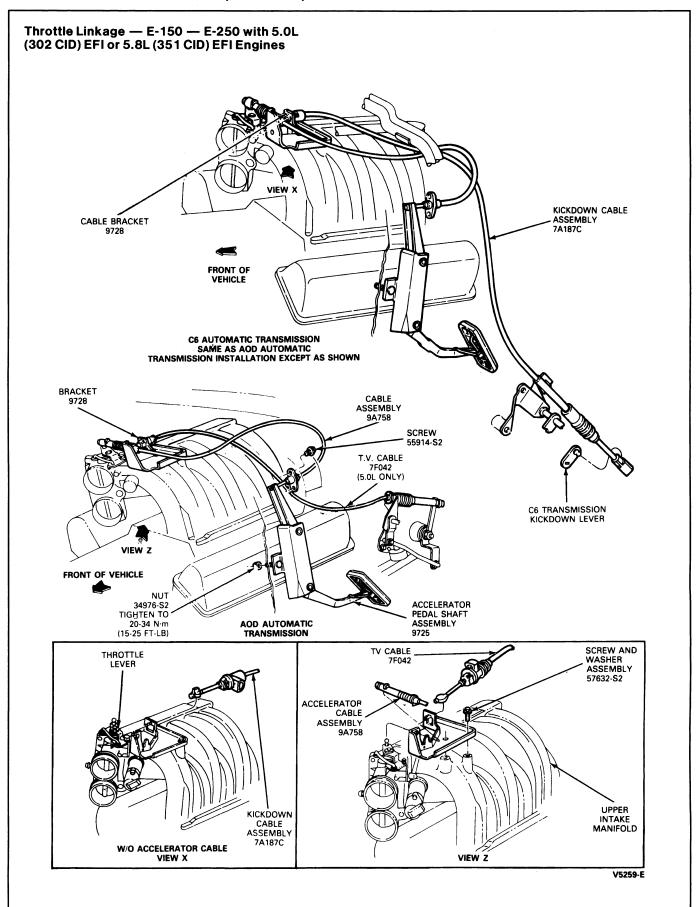
Remove two screws retaining bracket to intake manifold.

#### Installation

- Install two screws retaining bracket to intake manifold.
- 2. Install three screws retaining pedal shaft to dash.
- 3. Install cable to ball stud.
- 4. Install cable to mounting bracket.
- 5. Install two screws retaining cable to dash panel.
- 6. Install cable to pedal shaft.
- 7. For F-series vehicles, install two screws retaining shield to accelerator cable bracket.



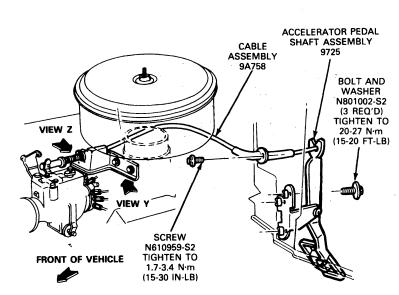
V4766-E



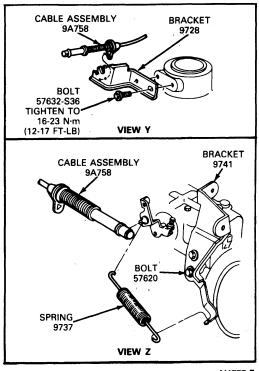
Throttle Linkage — 7.3L Diesel Engine

Refer to the following illustrations.

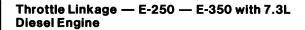
Throttle Linkage — F-250 — F-350 — F-Super Duty with 7.3L Diesel Engine

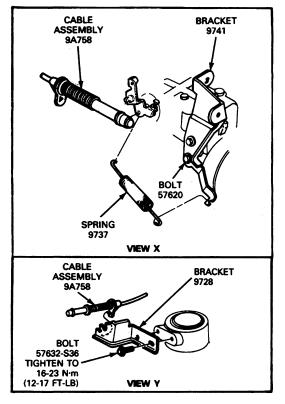


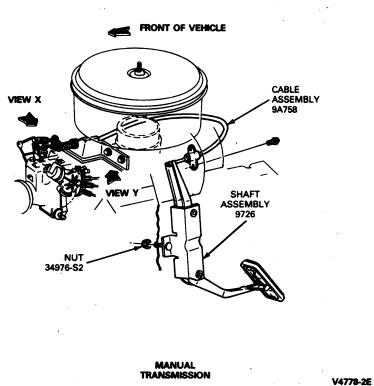
NO SURROUNDING ENGINE COMPARTMENT COMPONENTS (E.G.-WIRING, HOSES) MAY CONTACT ANY MOVING MEMBER OF THE ACCELERATOR CONTROLS. ALL VEHICLES ASSEMBLED ARE TO BE CHECKED FOR RETURN TO IDLE AS FOLLOWS: NO PERCEPTIBLE HESITATION OR PREVENTION OF RETURN TO THE IDLE POSITION MAY OCCUR DURING SLOW REMOVAL OF THE FOOT FROM THE ACCELERATOR PEDAL, STARTING AT THE FULLY DEPRESSED WIDE OPEN THROTTLE (W.O.T.) POSITION.

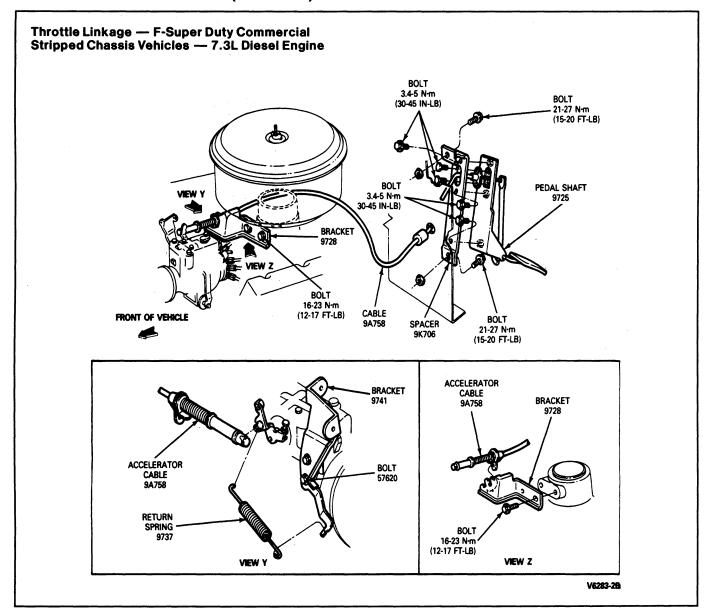


V4777-E









## **SECTION 10-03 Automatic Vehicle Speed Control**

| SUBJECT PAGE                                   | SUBJECT PAGE                                   |
|--|--|
| ADJUSTMENTS                                    | DIAGNOSIS AND TESTING (Cont'd.)                |
| Linkage Adjustment — Actuator Cable10-03-34    | Simulated Road Test10-03-21                    |
| Vacuum Dump Valve Adjustment10-03-34           | Speed Decreases — On Steep Grades Or Under     |
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#### **VEHICLE APPLICATION**

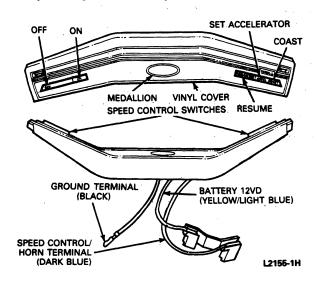
E-150—E-350, F-150—F-350, F-Super Duty and Bronco Vehicles

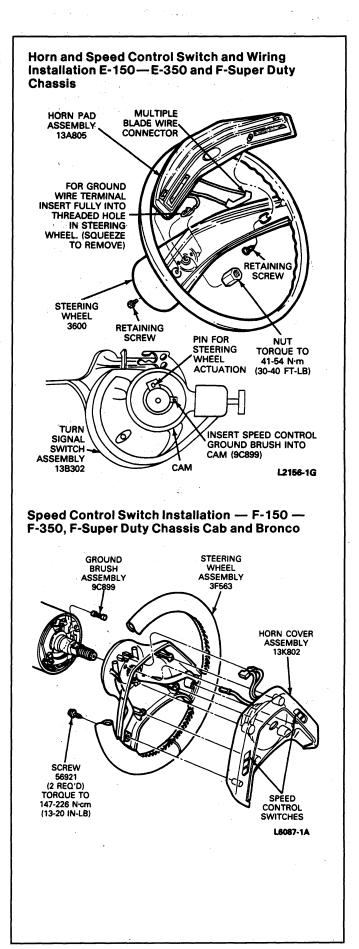
#### DESCRIPTION AND OPERATION

## Speed Control E-150—E-350, F-150—F-350, F-Super Duty and Bronco

The speed control system is comprised of the OFF-ON switch and the SET-ACCL, CST, RSM (ACCEL, COAST, RESUME on Econoline and F-Super Duty Strip Chassis) switches, a servo (throttle actuator) assembly, a speed sensor, a clutch position sensing switch (manual transmissions), an amplifier assembly and the necessary wires, linkage, and vacuum dump valve vacuum hose to connect the components. The 7.3L diesel engine incorporates a vacuum reservoir with an integrated check valve. The switches are located in the horn pad assembly. The amplifier assembly is located under the instrument panel. The servo assembly (throttle actuator) is attached as shown in the installation illustrations. The speed control sensor is located on the LH side of the transmission. To operate the speed control system the engine must be running and the vehicle speed over 48 Km/h (30 mph). Manifold vacuum is constantly supplied when the engine is running. When the ON/OFF switch in the steering wheel is momentarily actuated to the ON position the system is made ready to accept a set speed signal. When the vehicle has been accelerated and stabilized at a speed over 48 Km/h (30 mph) and the ON switch engaged, the operator may momentarily depress and release the SET/ACCL (ACCEL on Econoline) button. This speed will be maintained until a new speed is set by the operator, the brake pedal is depressed, the clutch pedal is depressed, the hazard lights are activated or the system or vehicle is turned off.

### Control Switch Installation E-150—E-350 and F-Super Duty Chassis Strip





#### **DESCRIPTION AND OPERATION (Continued)**

#### **Decreasing Set Speed**

The set speed may be reduced by applying the brake and then resetting the speed using the preceding method or by depressing the COAST/CST switch. When the vehicle has slowed to the desired speed the COAST/CST switch is released and the new speed is set automatically. If the vehicle speed is reduced below 48 Km/h (30 mph), the operator must manually increase the speed up to 48 Km/h (30 mph) and reset the system.

#### **Increasing Set Speed**

The vehicle set speed may be increased at any time by depressing the accelerator until the higher speed is reached and stabilized, then depressing and releasing the SET/ACCEL, ACCL button.

Speed may also be increased by depressing the SET/ACCEL, ACCL switch button, (at speeds over 48 Km/h (30 mph)), and holding it in that position. When the desired speed is attained and the button is released, that new set speed will be maintained.

#### **Resume Feature**

When the speed control system is deactivated by depressing the brake pedal or clutch pedal or activating the hazard light, the set speed prior to deactivation may be reestablished by momentarily depressing the RESUME/RSM switch. The resume feature is deactivated with the OFF switch, or if the vehicle speed has dropped below 48 Km/h (30 mph). In addition, when the ignition is turned to OFF, the speed control memory is erased and the RESUME/RSM feature will not function.

#### **Vacuum Dump Valve**

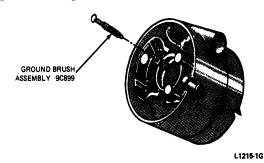
The vacuum dump valve provides a backup safety feature in the new system. Normally, when the brake pedal is depressed an electrical signal from the stoplamp switch to the amplifier will return the system to the stand-by mode. In addition, the vacuum dump valve will mechanically release the vacuum in the servo while the brake pedal is depressed, thus releasing the throttle independently of the amplifier control.

#### Vacuum Reservoir Assembly (7.3L Diesel Engine)

The vacuum reservoir assembly is provided to supply vacuum to the servo during peak demand. The reservoir is located on the grille support on Econoline and on the LH apron near the servo on F-Series. A check valve is integrated with the reservoir to prevent reverse vacuum flow. There are two 7.9mm (5/16-inch) diameter vacuum ports on the reservoir. The "VAC" port is connected by a 7.9mm (5/16-inch) I.D. vacuum hose to the vacuum source distribution port. The other port is connected by an identical vacuum hose to the speed control servo vacuum source port adjacent to the 6-way electrical connector.

#### **Ground Brush**

The speed control ground brush assembly provides an electrical ground path between the steering wheel hub and the turn signal switch when inserted into the turn signal canceling cam.



#### DIAGNOSIS AND TESTING

Speed control system tests should be performed using the Rotunda Speed Control Tester 007-00013 or equivalent. If the Rotunda Speed Control Tester 007-00013 is not available, use the following procedures.

NOTE: Diagnosis charts are provided at the end of this section to assist in locating speed control system problems.

#### **Visual Inspection**

A visual inspection is an important part of the system test. When performing a visual inspection, check all items for abnormal conditions such as frayed wires and damaged servo vacuum hoses. For the speed control system to function properly, it is necessary that the speedometer cables be properly routed and securely attached to the components. All vacuum hoses must be securely attached and routed with no sharp bends or kinks. The servo (throttle actuator) and throttle linkage should operate freely and smoothly. The actuator cable should be adjusted as tight as possible without opening the throttle plate or increasing the idle speed. Electrical connections must be complete and tight. The wiring harness must be properly routed. Look for frayed wiring insulation or evidence of shorts. Any problems revealed by the visual inspection should be corrected before further tests of the speed control system are made.

#### **Control Switches Test**

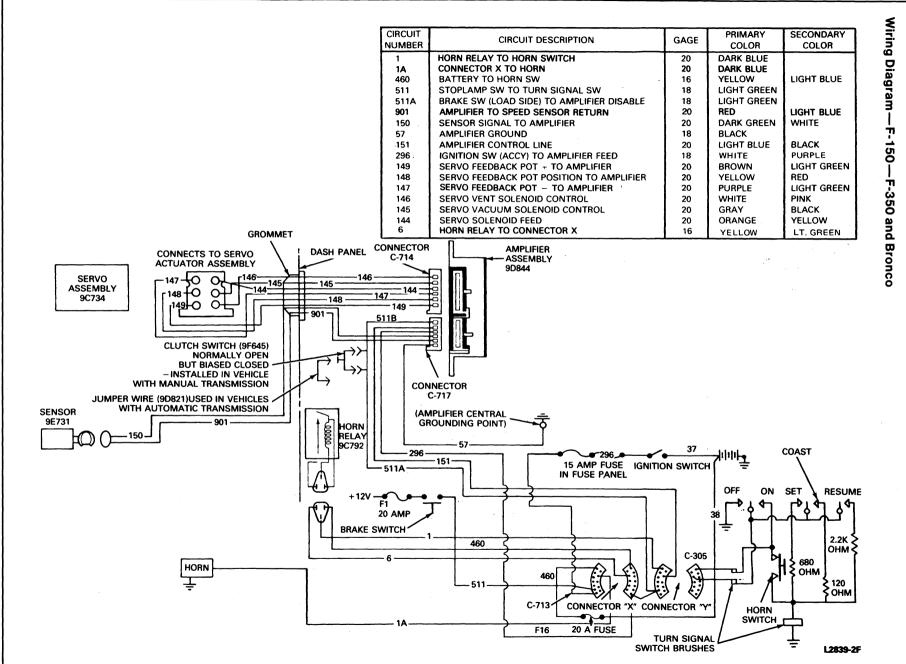
Disconnect the 6-way connector at the amplifier from the steering column control switches. Then, check the lead (light blue-black -151) from the control switches as follows:

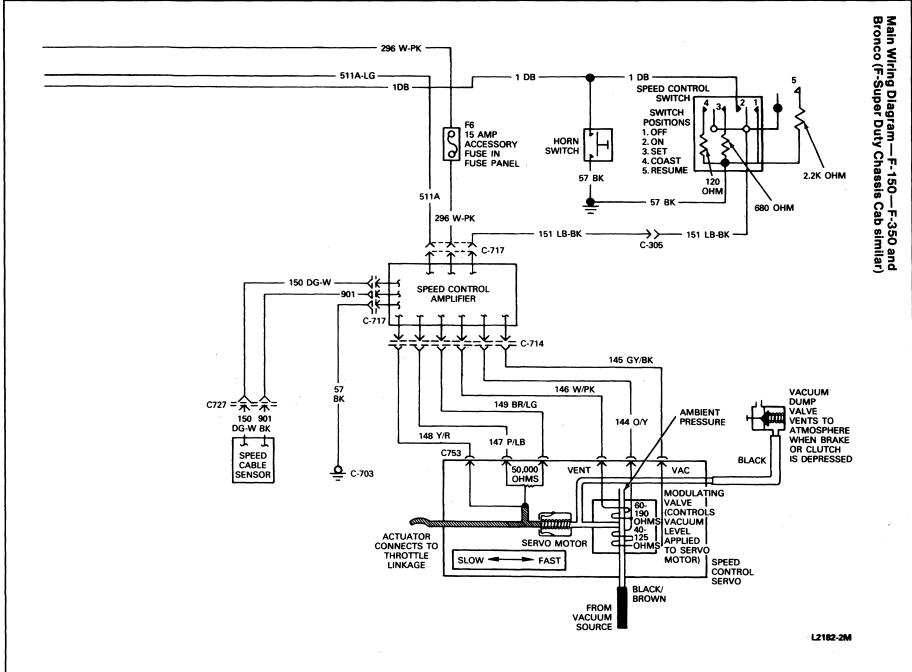
| NOTE: F-150—F-350, F-Super Duty Chassis Cab and Bronco switches are marked SET/ACCL and CST/RSM. | Check for battery voltage at the lead (light blue-black) when the ON switch is depressed.     Battery voltage should be available at the lead (light blue-black) coming from the control |
|--|--|
|  | switches. (Refer to the wiring diagram).   |
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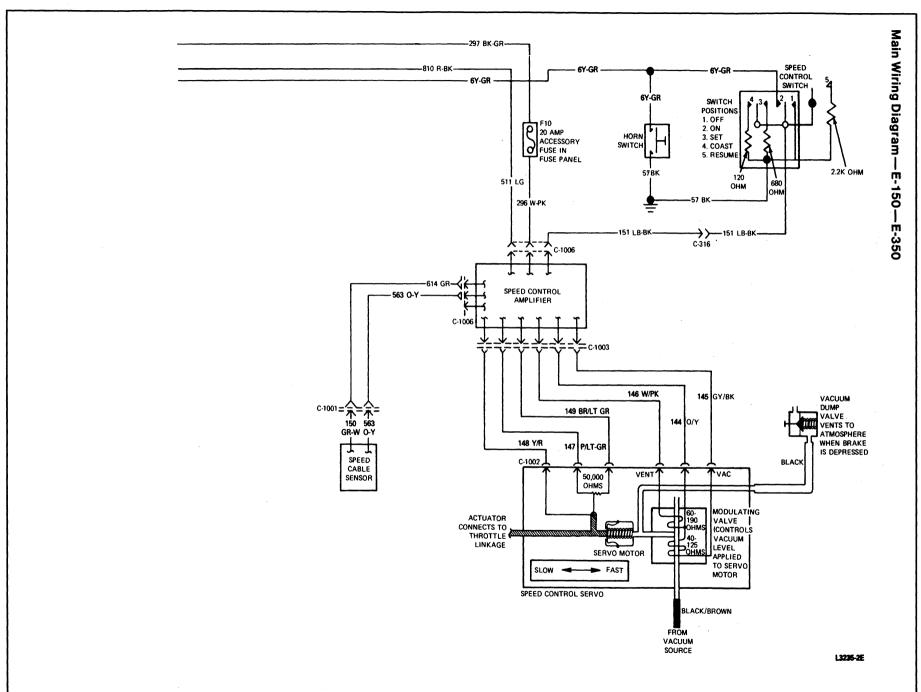
AND

TESTING

#### DIAGNOSIS Wiring Diagram HORN RELAY DASH PANEL 9C792 C-1003 D5AB-14468-MA GROMMET 9A840 D 146 D 145 D 144 D 147 **SERVO** 145 145 **ASSEMBLY** 9C734 148 E-150-148 AMPLIFIER ASSEMBLY 9D844 C-506 ♀ -E-350 810A 151 296 150 563 148 D2SB-14489-JA D2SB-14A468-BA (Continued) ۵ ON TRANSMISSION C-1001 Uo FEW-14461-A YELLOW SENSOR 57 150 296 🔾 —296 150 563 D5AB-14486-HA 9E731 + 12V TO 14401 BATTERY POWER C-1006 TO STEERING TO TO COLUMN HORN HORN TO FUSE RELAY C8AB-14463-C RELAY 4603 -1 -> TO HORN(S) -1->TO HORN RELAY 0 + 810 → TO BRAKE SWITCH -810->TO SPEED CONTROL AMPLIFIER то -150→ TO SPEED SENSOR 0-• SPEED 150 → TO SPEED CONTROL AMPLIFIER 563 → TO SPEED SENSOR CONTROL 563 → TO SPEED 296 296 CONTROL TO FUSE TO SPEED AMPLIFIER CONTROL **AMPLIFIER** SECONDARY CIRCUIT GAGE CIRCUIT DESCRIPTION COLOR NUMBER COAST HEADLAMP HORN RELAY TO HORN SWITCH SWITCH CONNECTOR X TO HORN BATTERY TO HORN SW STOPLAMP SW TO TURN SIGNAL SW BRAKE SW ILOAD SIDE: TO AMPLIFIER DISABLE DARK BLUE YELLOW LIGHT GREEN LIGHT GREEN 1A 460 511 511A CIRCUIT RESUME IGHT BLUE OFF ON SET 810A BREAKER CÓNN. AMPLIFIER TO SPEED SENSOR RETURN SENSOR SIGNAL TO AMPLIFIER AMPLIFIER GROUND AMPLIFIER CONTROL LINE LIGHT BLUE RED DARK GREEN + 12V BLACK LIGHT BLUE BLACK 296 149 148 147 AMPLIFIER CONTROL TOTAL IGNITION SW (ACCY) TO AMPLIFIER FEED SERVO FEEDBACK POT TO AMPLIFIER SERVO FEEDBACK POT POSITION TO AMPLIFIER SERVO FEEDBACK POT TO AMPLIFIER WHITE 810-2.2K **₹** BROWN LIGHT GREEN ō • OHM < RED LIGHT GREEN • • CONN. • • 0 PURPLE • "X" • SERVO PEEDBACK POI TO AMPLIFIE SERVO VENT SOLENOID CONTROL SERVO VACUUM SOLENOID CONTROL SERVO SOLENOID FEED HORN RELAY TO CONNECTOR X WHITE 9 • 0 GRAY ORANGE SI ACK OHM 0 YFLLOW 120 LT GREEN 810 563 BLACK YELLOW OHM 810 C-315 HORN TURN C-316 BRAKE I **SWITCH** HORN WIRING ASSEMBLY-9A840 SIGNAL → TO HAZARD FLASHER SWITCH TURN SIGNAL SWITCH SWITCH BRUSHES BRUSHES F8 C-1016 C-315 20A STEERING COLUMN DASH PANEL + 12V L2838-2F







- Connect an ohmmeter such as Rotunda Digital Volt-Ohm-Meter 007-00001 or an equivalent between the light blue-black wire (151) and ground. Check the wire for continuity to ground (0-1 ohm) when the OFF switch is depressed. If a resistance higher than 1 ohm is found, the wiring, slip rings, the copper brushes in the turn signal switch, or the switch is at fault, or the steering column is not properly grounded. To check for proper ground, connect an ohmmeter between any good electrical ground point on the body sheet metal and the steering column upper flange. Scrape away paint in a non-visible spot if necessary for good contact. The resistance should be less than 1/2 ohm. Rotate the steering wheel back and forth and check flexible coupling for resistance of less than 1 ohm. If resistance higher than 3 ohms is noted, clean the horn brush contacts and the ground brush (verify that the ground brush is installed). A resistance of less than 1 ohm must be obtained before performing the remaining tests.
- With an ohmmeter connected between the light blue-black wire (151) and ground, depress and hold the SET/ACCEL/ACCL switch. A reading of approximately 680 ohms should be indicated on the ohmmeter.

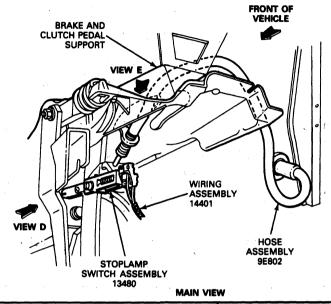
- With an ohmmeter connected between the light blue-black wire (151) and ground, depress and hold the COAST/CST switch. A reading of approximately 120 ohms should be indicated on the ohmmeter.
- With an ohmmeter connected between the light blue-black wire (151) and ground, depress and hold the RESUME/RSM switch. A reading of 2200 ohms should be indicated on the ohmmeter.

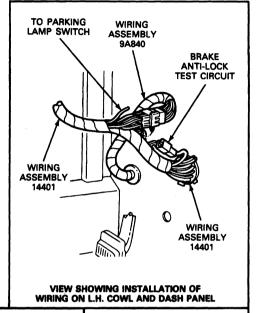
#### **Speed Sensor Test**

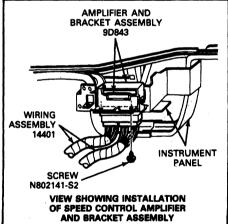
Disconnect the 6-way connector (C-1006 on E-150—E-350 and C-717 on F-150—F-350, Bronco) at the amplifier assembly, and connect an ohmmeter between the wire connector terminals (Dark Green-614 and Black-57 on E-150—E-350 and Dark Green—White Stripe-150 and Black-57A on F-150 through F-350 and Bronco) at the speed sensor end. A reading of approximately 200 ohms should be obtained. A reading of zero ohms indicates a shorted coil or wiring harness and a maximum reading indicates an open coil or wiring harness. Replace the sensor in either case.

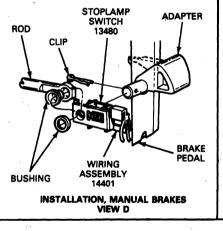
If the ohmmeter records 200 ohms and the speedometer operates properly within needle waver, the speed sensor is probably good. A speed sensor of known good quality can also be substituted for the existing sensor to check for proper operation.

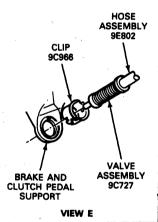




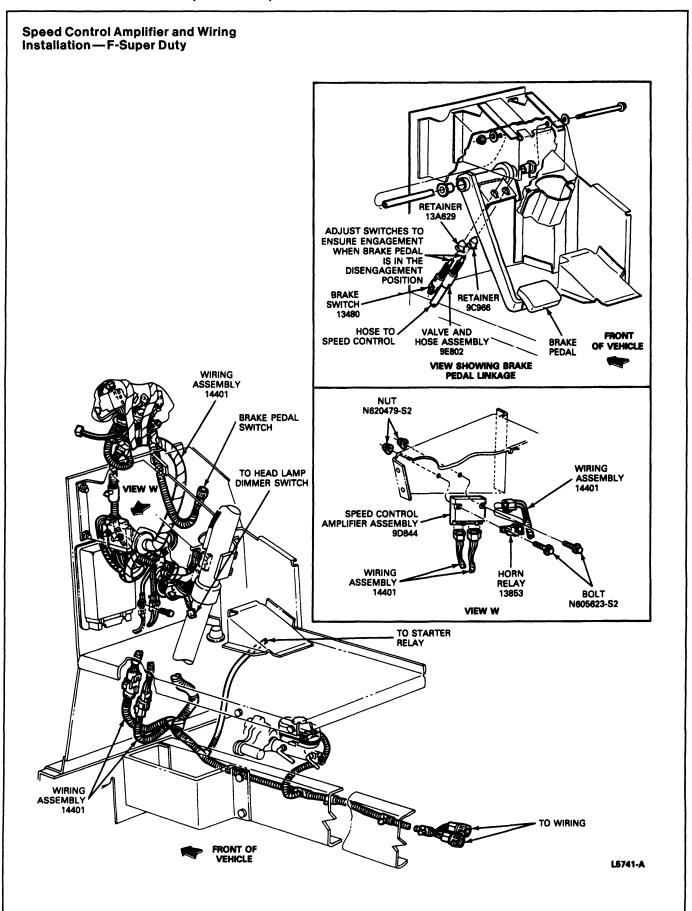


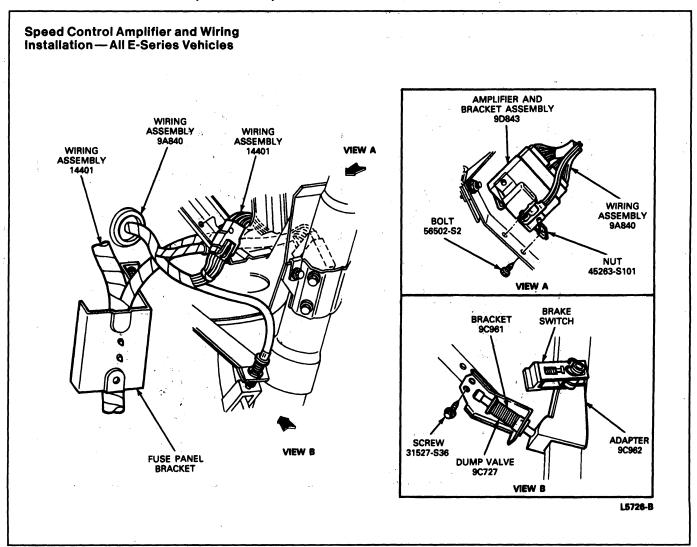






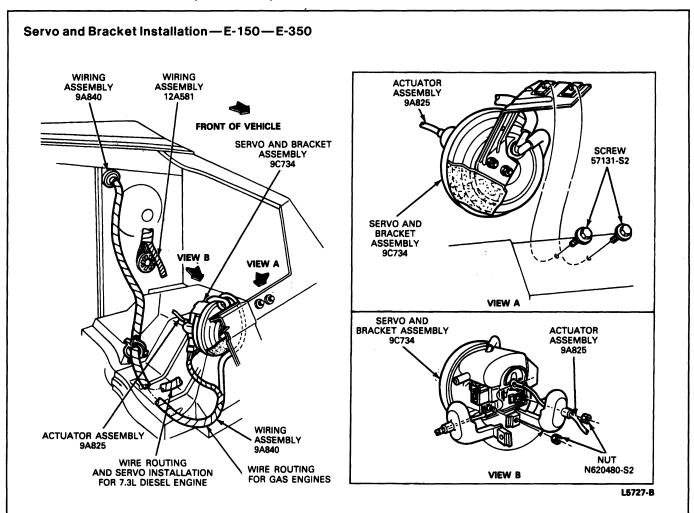
L5725-B

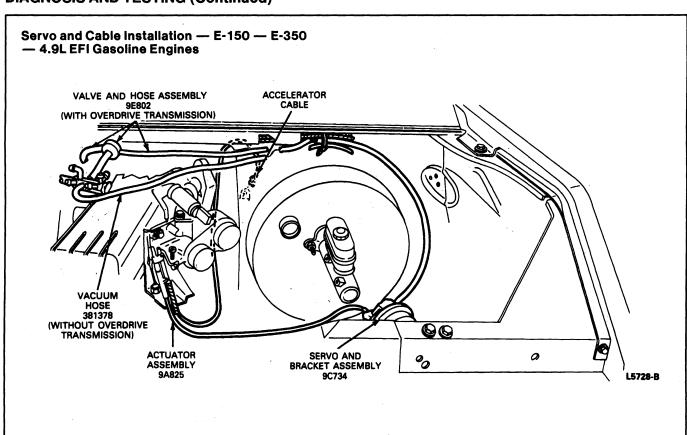


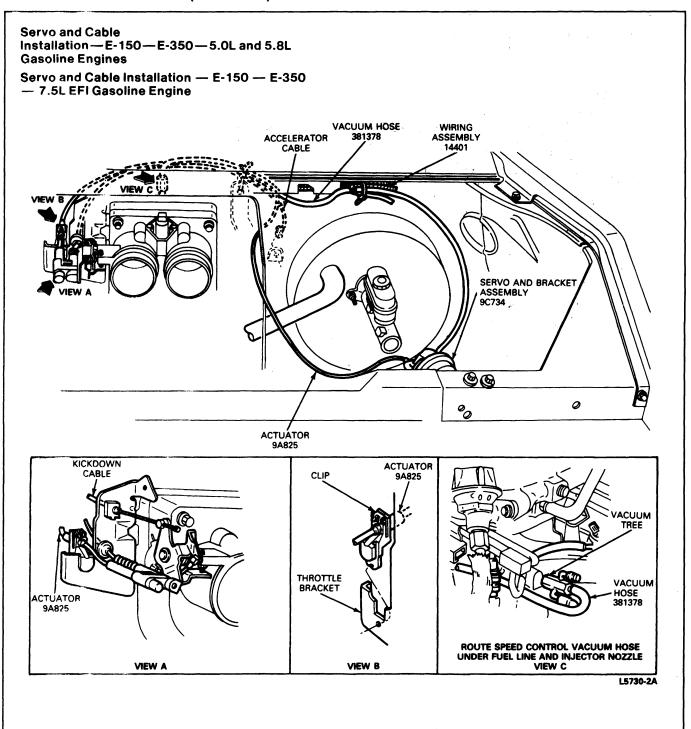


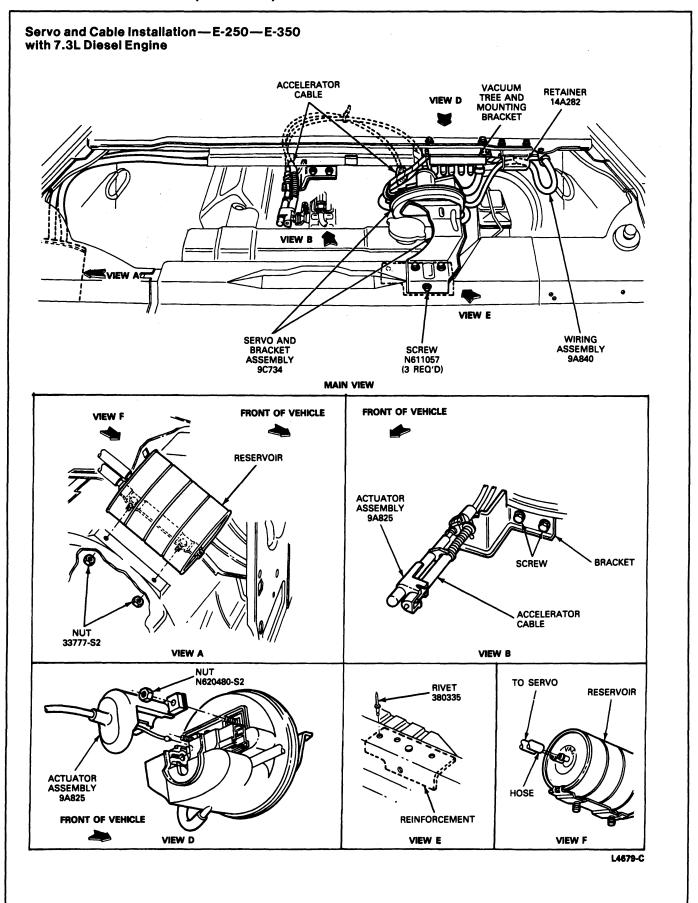
#### **Servo Assembly Test**

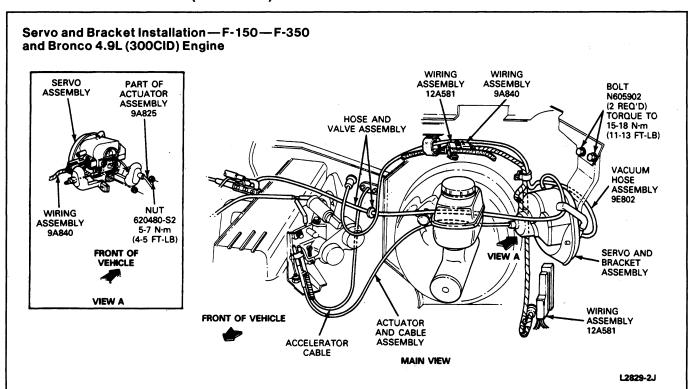
Disconnect the cable from the throttle body, if so equipped. Separate connector C-714 at the amplifier. Connect an ohmmeter between the orange-yellow wire 144 and gray-black wire 145 at the 8-way connector. A resistance of approximately 40 to 125 ohms should be obtained. Connect the ohmmeter between the orange-yellow 144 and white-pink wire 146. A resistance of approximately 60 to 190 ohms should be obtained. Reconnect the cable, if so equipped, to the throttle body and properly adjust.

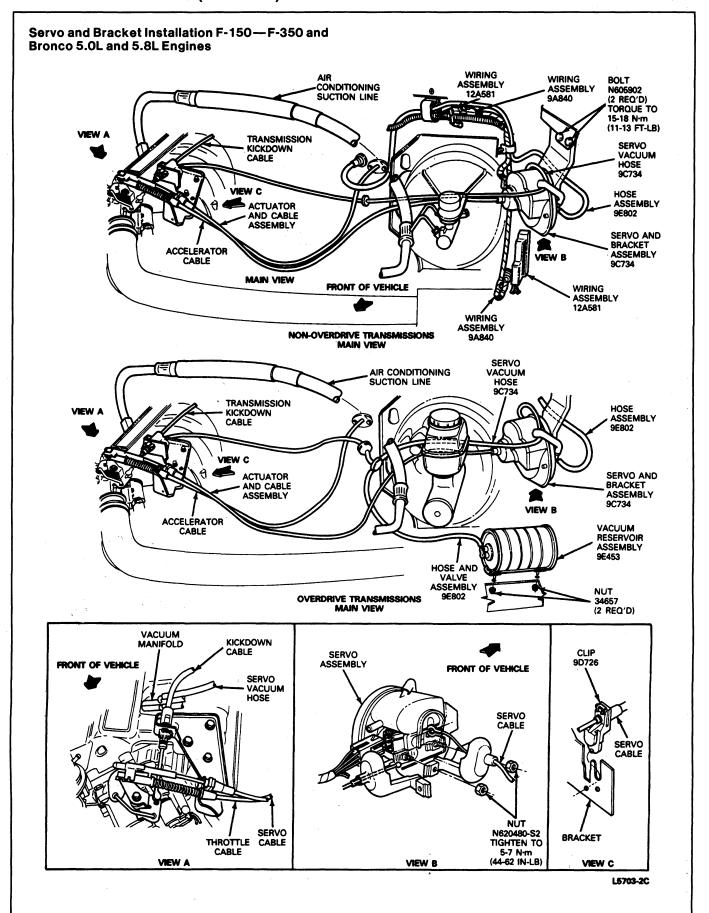


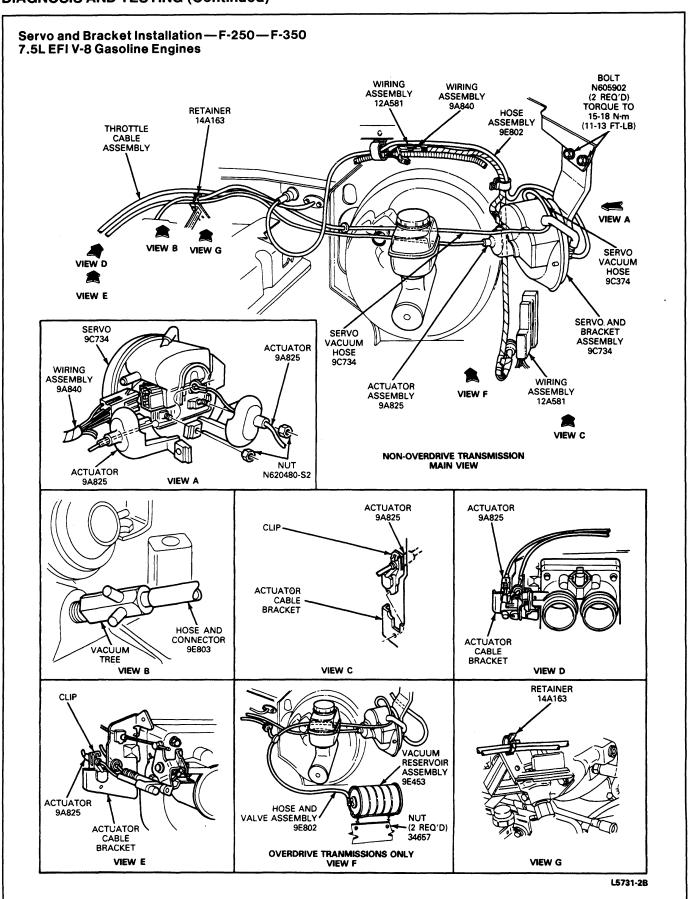


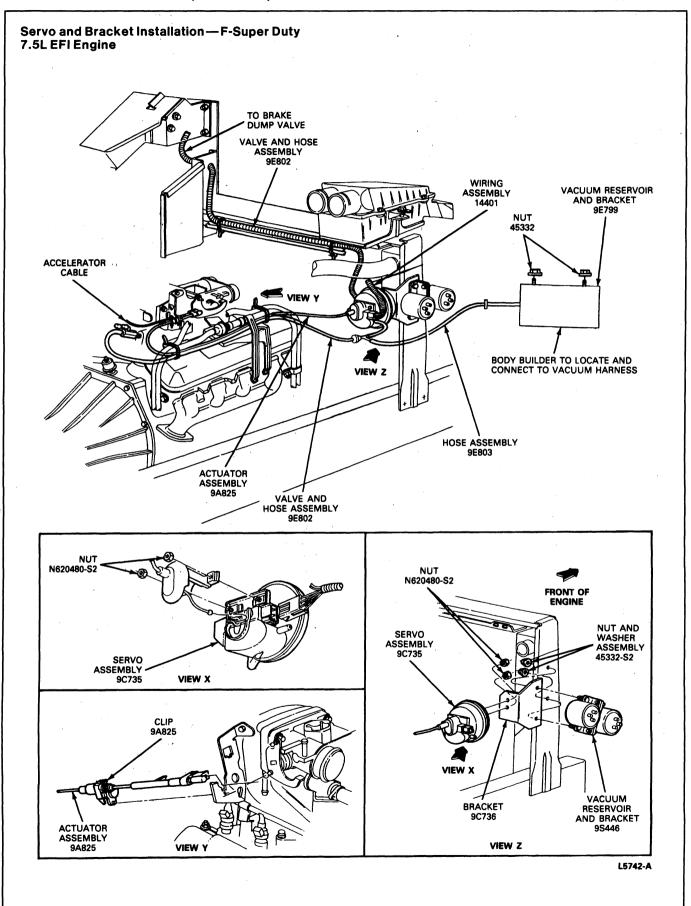












Start the engine, and verify servo vacuum from engine exceeds 2.5 inches Hg (1.22 psi). With the servo disconnected from the amplifier, connect the orange-yellow lead (wire 144) of the servo to the battery positive terminal. Connect the white-pink lead (wire 146) of the servo to ground, and momentarily touch the gray-black lead (wire 145) of the servo to ground. The servo throttle actuator should tighten the actuator cable and open the throttle. The throttle should hold in that position or slowly release the tension. When the white-pink wire is removed from ground, the servo should release actuator cable tension immediately. Replace the servo if it fails any part of the preceding test.

CAUTION: If the orange-yellow lead is shorted to either the white pink or gray-black leads, it may be necessary to replace the amplifier.

#### **Amplifier Test**

Do not use a test lamp to perform the following tests as excessive current draw will damage electronic components inside the amplifier. Use only a voltmeter of 5,000 ohm/volt rating or higher.

Do not substitute a new amplifier for the old amplifier until the actuator coils have been tested. Refer to the Servo Assembly (Throttle Actuator Test).

#### **ON Circuit Test**

Turn the ignition switch on and connect a voltmeter such as Rotunda Digital Volt-Ohm-Meter 007-00001 or an equivalent between ground and the wire lead (151) (light blue-black) at the amplifier connector (C-717 on F-150—F-350, Bronco and C-1006 on E-150—E-350). The voltmeter should read 12 volts when the ON switch on the steering wheel is depressed and held. If voltage is not available check the horn relay circuit and control switch test. Release the ON button; the voltmeter should read approximately 7.8 volts, indicating the ON circuit is engaged. If the voltage does not remain, check for bad connector 151 or ground contacts to amplifier, fuse and/or circuit breaker and/or hang in a known good amplifier and check for a good ON circuit.

#### **OFF Circuit Test**

With the ignition on and the voltmeter connected between ground and the light blue-black wire (151), depress the OFF switch on the steering wheel. Voltage on the blue wire should drop to zero indicating the ON circuit is de-energized. If the voltage does not drop to zero, perform the control switch test. If the switches check OK, hang in a known good amplifier and check the OFF circuit as above.

#### **Set-Accelerate Circuit Test**

With the ignition on and the voltmeter connected between ground and the light blue-black wire (151), depress the ON switch, then hold SET/ACCEL/ACCL button on steering wheel. Voltmeter should indicate approximately 4.5 volts. Rotate the steering wheel back and forth and watch the voltmeter for fluctuations. If the voltage varies more than 0.5 volt, perform the control switch test.

#### **Coast Circuit Test**

With the ignition on and the voltmeter connected between ground and the light blue-black wire (151), depress the ON switch, then hold the COAST/CST button on the steering wheel. Voltmeter should indicate approximately 1.5 volts. If all the functions check OK, perform the servo check and sensor test and hang in a known good amplifier.

#### **Resume Circuit Test**

With the ignition on and the voltmeter connected between the light blue-black mark wire in the six-way connector and ground, depress and hold the RESUME/RSM button on the steering wheel. The voltmeter should read approximately 6.5 volts.

If all the circuits check OK, perform the servo assembly test and hang in a known good amplifier.

#### **Simulated Road Test**

CAUTION: When performing this simulated road test, the rear wheels of the vehicle must be raised clear of the floor. Block the front wheels securely and use only a suitable lifting device (such as a garage-type hoist) and support the rear axle with one jack stand on each side. Never attempt to use the vehicle bumper jack for tests of this type.

- Start the engine.
- 2. Shift the transmission to DRIVE.
- 3. Turn on the speed control.

WARNING: IF ANY TIME DURING THE FOLLOWING STEPS THE SYSTEM SHOULD APPEAR TO GO OUT OF CONTROL AND OVERSPEED, BE PREPARED TO TURN THE SYSTEM OFF AT ONCE WITH THE OFF SWITCH OR THE IGNITION SWITCH.

- Accelerate in highest gear (manual transmissions) and hold at 56 Km/h (35 mph).
- Press and release the SET speed button. Hold foot pressure very lightly on accelerator pedal. Normally the speed will continue at 56 Km/h (35 mph) for a short period of time and then gradually start surging because the engine is not loaded.

- 6. Press the OFF button. The engine should drop back to idle. Stop the rear wheels with the brake.
- 7. Press ON button, accelerate and hold the speed at 56 Km/h (35 mph).
- Press and hold the SET/ACCEL/ACCL button. Slowly remove the foot from the accelerator. The engine speed should gradually increase.
- When the speed reaches 80 Km/h (50 mph), release the SET/ACCEL/ACCL button. The vehicle should maintain 80 Km/h (50 mph) for a short time before the surging begins.
- Press the COAST/CST button and hold. The engine should idle. Slow the rear wheels to 56 Km/h (35 mph).
- Release the COAST/CST button. Speed should set in. Surging should soon start.
- Press the brake pedal. The system should shut off, the engine should slow to idle and the wheels should stop.
- Set the speed at 80 Km/h (50 mph). Brake to 56 Km/h (35 mph) and maintain 56 Km/h (35 mph) with the accelerator. Depress and release the RESUME/RSM button. The speed should return to 80 Km/h (50 mph).

When performing these tests keep the vehicle speeds within reasonably low limits. If the system does not perform as normally expected, make note of the malfunction.

#### **Road Test**

- Start the engine. Perform speed control system road test in high gear with manual transmission or DRIVE with automatic transmission vehicles.
- 2. Turn on the speed control.

WARNING: IF ANY TIME DURING THE FOLLOWING STEPS THE SYSTEM SHOULD APPEAR TO GO OUT OF CONTROL AND OVERSPEED, TURN THE SYSTEM OFF AT ONCE WITH THE OFF SWITCH OR THE IGNITION SWITCH.

- 3. Accelerate and hold at 56 Km/h (35 mph).
- Press and release the set-speed button. Hold foot pressure very lightly on accelerator pedal. Normally the speed will continue at 56 Km/h (35 mph).
- Press the OFF button. The engine should decelerate.
- Press ON button, accelerate and hold the speed at 56 Km/h (35 mph).

- Press and hold the SET/ACCEL/ACCL button. Slowly remove foot from the accelerator. The engine speed should gradually increase.
- When the speed reaches 80 Km/h (50 mph), release the set-speed button.
- Press the COAST/CST button and hold. The engine should decelerate and slow to 56 Km/h (35 mph).
- Release the COAST/CST button. Speed should set in.
- 11. Press the brake pedal. The system should shut off causing the engine to idle.
- Set the speed at 80 Km/h (50 mph). Brake to 56 Km/h (35 mph) and maintain 56 Km/h (35 mph) with the accelerator. Depress and release the RESUME/RSM button. The speed should return to 80 Km/h (50 mph).

When performing these tests, keep the vehicle speeds within reasonably low limits. If the system does not perform as normally expected, make note of the malfunction.

## **Supply Circuit**

Blow the horn. This test will determine that there is power in the horn circuit to the steering wheel.

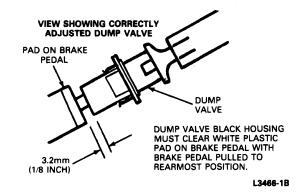
#### **Brake Stoplamp Switch and Circuit Test**

To be performed when brake application will not disconnect the speed control. On manual transmission vehicles, verify that clutch switch is correct, as outlined, before performing the following.

- Check for stoplamp operation with a maximum brake pedal effort of 26.7N (6 lb). If more than 26.7N (6 lb) effort is required, check the brake pedal actuation and stoplamp switch. Also, check for a burned out brake bulb. Repair or replace as required.
- If stoplamps work properly, check the battery voltage on the white-purple stripe lead 296 at the amplifier connector. Depress the brake pedal until the stoplamps are lit. Check voltage on the red-black stripe lead 810 (E-150—E-350) or on the light green wire (511A) (F-150—F-350 and Bronco) at the same connector. The voltage difference between leads 296 and 810 (Econoline) or 511A (F-Series, Bronco), must not exceed 1.5 volts. The high resistance must be found and corrected in the stoplamp circuit.
- If the stoplamps do not work, the stoplamp switch, supply circuit, fuses or bulbs must be checked.

### **Vacuum Dump Valve Test**

The vacuum dump valve releases the vacuum in the servo assembly whenever the brake pedal is depressed. It should be checked whenever brake application does not disconnect the speed control. The dump valve should be pushed sufficiently forward in the retainer clip so that no more than 3.2mm (1/8 inch) of the white (black on Econoline) plunger is showing when the brake pedal is in the released position.



Disconnect the vacuum hose from the dump valve to the servo at the servo. Connect a hand vacuum pump such as Rotunda 021-00037 or equivalent, to the hose, and pump up a vacuum. If a vacuum cannot be obtained, the hose or the dump valve leaks and should be replaced or adjusted. Step on the brake pedal. The vacuum should be released. If it is not, adjust as described below:

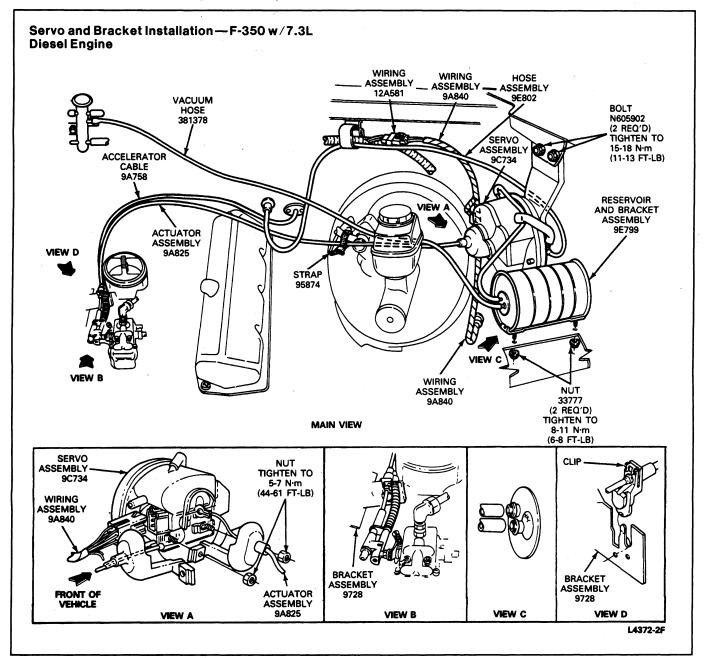
- Move the valve forward in the retaining clip with the valve plunger contacting the brake pedal adapter and the pedal in the released position until 3.2mm (1/8 inch) or less of the plunger shows.
- Ensure brake pedal is against the stop in the release position after adjustment.

If vacuum still does not release, replace vacuum dump valve.

#### **Vacuum Reservoir Test**

To test the vacuum reservoir and check valve for vacuum leakage, proceed as follows:

- Locate vacuum reservoir on LH apron.
   Disconnect vacuum hose at the servo and connect hose to a vacuum gauge with a minimum range of 0-85 kPa (0-25 inches Hg).
- Start the engine and observe that the vacuum level exceeds 67.4 kPa (20 in. Hg) [77.5 kPa (23 in. Hg) is nominal.] If not, check for leaky vacuum source hose or damaged vacuum pump.
- Turn off the engine after the vacuum level has stabilized above 67.4 kPa (20 in. Hg). The vacuum level should remain essentially constant and after 24 hours should still exceed 50.5 kPa (15 in. Hg).
- If the vacuum level can not be maintained, the reservoir should be replaced.



# Horn Relay Circuit Test—E-150—E-350, F-150—F-350 and Bronco

Refer to Wiring Diagrams.

- Locate horn relay wire connector on the wiring diagram.
  - NOTE: Connectors remain connected for the following tests.
- 2. Locate yellow-light blue wire (460).
- Using voltmeter, measure for battery voltage (approximately 12V) on the pin side of the connector to ground.

- Locate yellow-light green stripe wire (6) (E-150—E-350) or dark blue (1) (F-150—F-350 and Bronco).
- Using voltmeter, measure for battery voltage (approximately + 12V) on socket side of connector.
- With voltmeter still connected to socket lead in step 5, depress horn switch. Voltmeter should read zero. Horn should sound.
- If voltmeter reading remains at +12V when horn switch is depressed, horn switch or steering column wiring has an open circuit.

- Before continuing, prove out horn relay by momentarily grounding circuit (1) (F-150—F-350 and Bronco) or circuit 6 (E-150—E-350) to body electrical ground or body sheet metal and the horn should sound. This test bypasses horn switch.
- With circuit from step 8 grounded, if the horn still does not sound, check for approximately + 12V on the dark blue wire (1) (E-150—E-350) or yellow—light green wire (6) (F-150—F-350 and Bronco) when relay operates.
- If voltage is present at circuit from step 9 when the relay is operated, an open circuit is present between the horn relay connector and the horn.
- If the relay does not operate with + 12V on circuit (460) and circuit from step 8 grounded, replace the relay.

NOTE: The horn and/or speed control may operate intermittently if the ground brush is missing.

### Clutch Switch Test—F-150—F-350, E-150—E-350 and Bronco

#### **Manual Transmission**

The speed control system is designed to disengage when the clutch pedal is depressed. This is accomplished through a clutch disable switch.

The disengage function operates by opening the 511 circuit (F-150—F-350 and Bronco) or the 810 circuit (E-150—E-350) between the speed control module and the stoplamps. This prevents engine overspeed when the clutch is depressed and the speed control is engaged.

The switch is a plastic plunger type mounted to the brake and clutch pedal support on the side near the driver's door. It is actuated by the clutch pedal arm.

NOTE: The switch functions magnetically through a reed switch. Do not use magnetized tools near this switch.

If the switch is open when the clutch pedal is released, the speed control will not operate. This must be corrected before making other tests.

CAUTION: Do not use a test lamp to perform the following tests because a lamp cannot properly indicate condition of switch. Use only a voltmeter of 5,000 ohm/volt rating or higher.

To check the switch, disconnect the switch pigtail connector from the speed control harness connector and connect an ohmmeter to the two-switch connector terminals. With the clutch pedal in the full up (released) position the resistance should be less than 5 ohms. With the clutch pedal depressed (switch plunger extended) the circuit should be open.

#### **Automatic Transmission**

Vehicles equipped with automatic transmissions use a shorting plug instead of a clutch switch.

# Speed Decreases—On Steep Grades Or Under Heavy Loads—Test

Verify that a complaint regarding a decrease in speed during high inclines or under heavy-load conditions is not caused by a powertrain limitation. To verify, conduct a road test. Set the speed at about 88.5 Km/h (55 mph) and proceed up a steep grade. When the speed decreases 6.4 to 9.7 Km/h (4 to 6 mph), manually accelerate the vehicle. Verify that the vehicle can maintain the SET speed without causing transmission kickdown (a transmission down-shift is acceptable with the overdrive transmissions). If SET speed can be maintained manually, a problem exists with the speed control system (e.g., bead chain needs adjustment, vacuum leak or vacuum source not connected to the 7.9mm (5 / 16 inch) port, a damaged servo or amplifier, etc.). If SET speed cannot be maintained without a transmission kickdown, the speed control system is normal and the powertrain capacity is the limiting factor.

NOTE: When the vehicle speed decreases about 16.1 Km/h (10 mph) below the SET speed, the speed control system will, by design, cancel control (similar to the cancellation that occurs when the stoplamps are activated). The servo requires a 8.5 kPa (2.5 inch Hg) minimum vacuum source for normal operation.

## **Diagnosis Guides**

The speed control system diagnosis guides in this section can be used to determine and isolate speed control problems.

|           | TEST STEP   | RESULT   |                | ACTION TO TAKE   |
|-----------|---|----------|----------------|--|
| A0        | VERIFY THE CONDITION  |          |                | GO to A1.  |
| A1        | CHECK CONNECTIONS   |          |                |  |
|           | Check all electrical and vacuum connections.  | (        | OK) ▶          | GO to <b>A2</b> .  |
|           |   | (        | <b>∌</b> ►     | SERVICE or REPLACE as required.                                      |
| A2        | CHECK BRAKE LAMP  |          |                |  |
|           | <ul> <li>Press brake pedal.</li> <li>Check to see that brake lamp is operating.</li> </ul>  | (        | ® <b>►</b>     | GO to A3 if manual transmission. If automatic transmission GO to A4. |
|           |   |          | <b>∌</b> ►     | SERVICE brake lamp circuit.  |
| <b>A3</b> | CHECK CLUTCH SWITCH (MANUAL TRANSMISSION)   |          |                | . 9  |
|           | Check clutch switch for proper operation.   |          | ® ►            | GO to <b>A4</b> .  |
|           |   | <u> </u> | Ø►             | SERVICE as required.   |
| 44        | CHECK THROTTLE ACTUATOR   |          |                | * **   |
|           | Check throttle actuator bead chain (or cable).  | (        | <b>⊗</b> ►     | GO to <b>A5</b> .  |
|           |   | <b>(</b> | $\mathfrak{F}$ | SERVICE as required.   |
| <b>\5</b> | CHECK LINKAGE OPERATION   |          |                |  |
|           | Check the throttle linkage for proper operation.  | (        |                | GO to <b>A6</b> .  |
|           |   | (        | <b>⋈</b> ►     | SERVICE as required.   |
| <b>A6</b> | CHECK VACUUM  |          |                |  |
|           | <ul> <li>Check vacuum at servo.</li> <li>NOTE: 2.5 inches of Hg (1.22 psi) is minimum vacuum</li> </ul>   | (        | B ►            | GO to A8.  |
|           | for normal servo operation. The vacuum source hose is attached to the 7.9mm (5/16 inch), vacuum fitting port or the vacuum reservoir "VAC" port with the 7.3L diesel engine. The servo vacuum source hose is connected to the unmarked vacuum reservoir port. | Q        | Ŋ́►            | GO to A7.  |
| ١7        | CHECK DUMP VALVE  |          |                |  |
|           | Check vacuum dump valve.  | 6        | B              | SERVICE or REPLACE vacuum hose as required.                          |
|           |   | 6        | <b>X</b>       | SERVICE or ADJUST as   |

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|     | TEST STEP  | RESULT                | ACTION TO TAKE  |
|-----|--|-----------------------|---|
| A8  | PERFORM CONTROL SWITCHES AND CIRCUIT TESTS   |                       |   |
|     | <ul> <li>Perform control switches and circuit tests as<br/>described in this Section.</li> </ul> | Ø <b>⊗</b> ▶          | GO to A9.   |
|     |  | Ø.                    | SERVICE circuit or REPLACE horn pad assembly as required. |
| A9  | PERFORM SERVO TESTS  |                       |   |
|     | Perform servo tests as described in this Section.  | ØK ▶                  | GO to <b>A10</b> .  |
|     |  | <b>∅</b> •            | REPLACE actuator.   |
| A10 | PERFORM SENSOR TEST  |                       |   |
|     | Perform sensor test as described in this Section.  | (OK) ▶                | GO to A11.  |
|     |  | <b>∅</b> •            | REPLACE sensor.   |
| A11 | PERFORM AMPLIFIER TEST   |                       |   |
|     | <ul> <li>Perform amplifier test as described in this Section<br/>(Substitution)</li> </ul>       | Problem corrected     | INSTALL a new amplifier.                                  |
|     |  | Problem not corrected | EXAMINE all connecto                                      |

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carefully for proper contact. REPAIR as required. REMOVE substitute amplifier.

|    | TEST STEP   | RESULT  | ACTION TO TAKE   |
|----|---|---|--|
| B0 | VERIFY THE CONDITION  |   |  |
|    | Note carefully when intermittent action occurs.   |   | GO to <b>B1</b> .  |
| B1 | INSPECT VISUALLY  |   |  |
|    | Perform visual inspection test.   | If intermittant action occurs while cruising  | GO to <b>B2</b> .  |
|    |   | If intermittent action occurs while using control buttons or turning steering wheel | GO to <b>B4</b> .  |
| B2 | CHECK VACUUM TO SERVO   |   |  |
|    | Check vacuum supply to servo.   | <b>⊗</b> ►  | GO to <b>B3</b> .  |
|    | NOTE: 2.5 inches of Hg (1.22 psi) is minimum vacuum for normal servo operation. The vacuum source hose is attached to the 7.9 mm (5/16 inch) engine vacuum-fitting port or the vacuum reservoir "VAC" port with the 6.9L diesel engine. | Ø <b>►</b>  | SERVICE vacuum supply.   |
| B3 | PERFORM SERVO ASSEMBLY TEST   |   |  |
|    | <ul> <li>Perform servo assembly test. Lightly tap servo body<br/>while making test.</li> </ul>  |   | SUBSTITUTE known good amplifier if OK properly INSTALL amplifier.  |
|    |   | Ø►  | REPLACE servo assembly.  |
| B4 | PERFORM CONTROL SWITCHES AND CIRCUIT TESTS  |   |  |
|    | <ul> <li>Perform control switches and circuit tests as<br/>described in this Section.</li> </ul>  | <b>⊙</b> K ►  | SUBSTITUTE known good amplifier if OK — properly INSTALL amplifier.  |
|    |   | <b>∅</b> ►  | REPAIR circuits,<br>REPLACE horn pad<br>assembly. CLEAN or<br>SERVICE three coppe<br>brushes and steering<br>wheel ring. |

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# SPEED CONTROL OPERATES BUT DOES NOT ACCELERATE OR COAST DOWN PROPERLY

|    | TEST STEP  | RESULT       | ACTION TO TAKE  |
|----|--|--------------|---|
| CO | PERFORM VISUAL INSPECTION TEST   |              |   |
|    | Visually inspect system.   | <b>⊗</b> ▶   | GO to <b>C1</b> .   |
|    |  | <b>∅</b> ►   | SERVICE or REPLACE affected circuit.                            |
| C1 | PERFORM CONTROL SWITCHES AND CIRCUIT TESTS                               |              |   |
|    | Perform control switches and circuit tests as described in this Section. | ØK ▶         | GO to <b>C2</b> .   |
|    |  | <b>∅</b> ▶   | SERVICE circuits or REPLACE horn pad assembly.                  |
| C2 | PERFORM SERVO ASSEMBLY TEST  |              |   |
|    | Perform servo assembly test as described in this Section.                | Ø <b>8</b> ▶ | SUBSTITUTE known<br>good amplifier if OK,<br>REPLACE amplifier. |
|    |  | <b>∅</b> ▶   | REPLACE servo assembly.   |

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|    | TEST STEP  | RESULT                   |                       | ACTION TO TAKE   |
|----|--|--------------------------|-----------------------|--|
| D0 | VERIFY CONDITION   |                          |                       | GO to D1.  |
| D1 | CHECK THROTTLE ACTUATOR  |                          | * 4                   |  |
|    | Check throttle actuator for proper operation and adjustment.                               |                          |                       | GO to <b>D2</b> .  |
|    |  | 1                        |                       | SERVICE or ADJUST as required.   |
| D2 | CONTINUITY CHECK   |                          |                       |  |
|    | Check continuity of circuits 147, 148 and 149 on   |                          | (N)                   | GO to <b>D3</b> .  |
|    | F-150 — F-350 and Bronco, Check continuity of  |                          |                       | 40 to <b>53</b> .  |
|    | circuits 735, 827 and 828 on E-150 — E-350.  |                          | Ø ►                   | REPAIR or REPLACE wiring as necessary.                                     |
| D3 | TEST SERVO   | ].                       |                       | •  |
|    | Perform servo test as described in this Section.   |                          | ØK ▶                  | GO to D4.  |
|    |  |                          | <b>⊗</b> ▶            | REPLACE as required.   |
| D4 | CHECK SPEEDOMETER CABLES   |                          |                       |  |
|    | Check speedometer cables for proper routing, no  | ]                        | (OK) <b>▶</b>         | GO to <b>D5</b> .  |
|    | sharp bends or binding.  |                          |                       |  |
|    | • • • • • • • • • • • • • • • • • • •  |                          | (XK) -                | SERVICE as required.   |
| D5 | CHECK SENSOR   | 4                        |                       |  |
|    | Check sensor for free operation. At 30 mph, the  | ** .                     | (OK)                  | GO to <b>D6</b> .  |
|    | output voltage is constant in the range 2.5-4.9 V.R.MS with a 4K ohms resistance load coil |                          | $\widetilde{\otimes}$ | REPLACE sensor.  |
|    | resistance is 200 ohms.  | <del> </del>             | 2                     |  |
| D6 | TEST SENSOR  | _                        |                       |  |
|    | • Perform sensor test as described in this Section.  | }                        | ØK ▶                  | GO to <b>D7</b> .  |
|    |  |                          | (M)                   | REPLACE speed  |
|    |  |                          |                       | sensor.  |
| D7 | CHECK DUMP VALVE   | ,                        |                       |  |
|    | Check vacuum dump valve.   |                          | ØK ▶                  | GO to <b>D8</b> .  |
|    |  |                          | Ø►                    | SERVICE or ADJUST as required.   |
| D8 | TEST AMPLIFIER   |                          |                       | roquirou.  |
|    | · · · · · · · · · · · · · · · · · · ·  | 1                        |                       | DEDI AGE A SE  |
|    | <ul> <li>Perform amplifier test as described in this Section.</li> </ul>                   | Corrects problem         |                       | REPLACE amplifier.   |
|    |  | Does not correct problem | <b>&gt;</b>           | CHECK circuit<br>connections for good<br>contacts. SERVICE as<br>required. |

# SPEED CONTROL DOES NOT DISENGAGE WHEN BRAKES ARE APPLIED

|            | TEST STEP  | RESULT                   | ACTION TO TAKE  |
|------------|--|--------------------------|---|
| E0         | VERIFY THE CONDITION                                 |                          | GO to E1.   |
| E1         | CHECK STOPLAMPS                                      |                          |   |
|            | Apply brakes and observe stop lamps.                 | <b>⊗</b> ►               | GO to E2.  SERVICE stoplamp circuit as required. VERIFY fuses are not open. GO to E2. |
| E2         | CHECK DUMP VALVE                                     |                          |   |
|            | Check vacuum dump valve.                             | (OK) <b>▶</b>            | GO to <b>E3</b> .   |
|            |  | <b>∅</b> ►               | ADJUST or SERVICE as required.  |
| <b>E</b> 3 | CHECK SERVO  |                          |   |
|            | Check servo operation and throttle linkage.          | <b>⊘</b> k <b>►</b>      | GO to E4.   |
|            |  | <b>∅</b> ►               | REPLACE servo.  |
| E4         | TEST AMPLIFIER                                       |                          |   |
|            | Perfrom amplifier test as described in this Section. | Corrects problem         | REPLACE amplifier.  |
|            |  | Does not correct problem | CHECK contacts of green connector. SERVICE as required.                               |

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|    | TEST STEP  | RESULT      | <b>—</b>    | ACTION TO TAKE   |
|----|--|-------------|-------------|--|
| F0 | VERIFY THE CONDITION   |             |             | GO to F1.  |
| F1 | CHECK THROTTLE ACTUATOR                                      |             | ٠.          |  |
|    | Check throttle actuator for proper operation and adjustment. |             | <b>)</b>    | GO to F2.  |
|    |  | <u>@</u>    | <b>∮</b> ►  | ADJUST or SERVICE as required.                                   |
| F2 | CHECK CONNECTIONS  | ·           |             |  |
|    | Check system circuit connections.                            | (F)         | ) >         | GO to <b>F3</b> .  |
|    |  | (A)         | <b>5</b>    | SERVICE as required.   |
| F3 | CHECK CONTROL SWITCH   | <u> </u>    |             |  |
|    | Check control switch circuit.                                | (P          | <b>)</b>    | GO to F4.  |
|    |  | Ø           | <b>5</b>    | SERVICE switch circuit as required.                              |
| F4 | CHECK DUMP VALVE   |             |             | *  |
|    | Check vacuum dump valve.                                     | (Or         | <b>)</b>    | GO to F5 for manual transmission, F6 for automatic transmission. |
|    |  | Ø           | <b>5</b>    | ADJUST or SERVICE as required.                                   |
| F5 | CHECK CLUTCH SWITCH  |             |             |  |
|    | Check clutch switch.   | (OK         | <b>)</b>    | GO to F6.  |
|    |  | Ø           | <b>&gt;</b> | SERVICE switch as required.                                      |
| F6 | CHECK STOPLAMPS  |             |             |  |
|    | Check stoplamps, switch and circuit.                         |             | ) 🕨         | GO to F7.  |
|    |  | <b>(</b> ** |             | SERVICE lamps and circuit as required.                           |
| F7 | CHECK SERVO  |             |             | and an inquire   |
|    | Check servo for proper operation.                            |             | <b>)</b>    | GO to <b>F8.</b>   |
|    |  | l Ø         | , 1         | REPLACE servo.   |
| F8 | CHECK SENSOR   | <u> </u>    |             |  |
|    | Check speed control sensor.                                  | <b>O</b> K  | <b>)</b>    | CHECK amplifier,<br>REPLACE as required.                         |
|    |  |             |             | REPLACE sensor.  |

# SPEED CONTROL SYSTEM DOES NOT DISENGAGE WHEN CLUTCH PEDAL IS DEPRESSED (MANUAL TRANSMISSION ONLY)

|    | TEST STEP   | RESULT |             | ACTION TO TAKE                                      |
|----|---|--------|-------------|---|
| GO | VERIFY  |        |             |   |
|    | <ul> <li>Verify system disengages when stoplamp switch is activated.</li> </ul> | (OH    | <b>)</b>    | SERVICE or REPLACE wire assembly 9A840 as required. |
|    | Check clutch switch operation.  | Ø      | <b>&gt;</b> | SERVICE or REPLACE as required.                     |

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### SPEED GRADUALLY INCREASES OR DECREASES AFTER SPEED IS SET

|    | TEST STEP   | RESULT     | ACTION TO TAKE                               |
|----|---|------------|--|
| НО | VERIFY*   |            | '.   |
|    | Verify that engine is properly tuned.               | <b>⊗</b> ► | GO to H1.                                    |
|    | Check accelerator action and head chain adjustment. | <b>∅</b> ► | ADJUST or CORRECT as required.               |
| H1 | CHECK DUMP VALVE                                    |            |  |
|    | Check vacuum dump valve.                            | Øk ►       | GO to <b>H2</b> .                            |
|    |   | <b>∅</b> ► | ADJUST or SERVICE as required.               |
| H2 | TEST SERVO  |            |  |
|    | Perform servo test.                                 | ØK ►       | PERFORM amplifier test. REPLACE if required. |
|    |   | <b>⊗</b> ► | REPLACE servo.                               |

\*Perform "Speed Decreases — On Steep Grades or Under Heavy Loads" test in this Section.

CL4370-2C

#### SPEED CONTROL OPERATES BUT DOES NOT RESUME ACCELERATE OR COAST DOWN PROPERLY **TEST STEP** RESULT **ACTION TO TAKE** JO **VERIFY THE CONDITION** GO to J1. J1 CHECK FOLLOWING SWITCHES AND CIRCUITS • Check the SET-ACCEL switch, Coast switch, GO to **J2**. RESUME switch and slip ring circuits and brush contacts. SERVICE the circuit as required. J2 **TEST SERVO** Perform servo test. GO to J3. REPLACE servo. **TEST AMPLIFIER** J3 • Perform amplifier test as described in this Section. Corrects problem. REPLACE amplifier. Does not correct **CHECK** circuit problem. connections for proper contact. SERVICE as required.

#### **ADJUSTMENTS**

## Linkage Adjustment—Actuator Cable

- Snap the molded speed control actuator cable retainer over the accelerator cable end fitting attached to the throttle ball stud.
- Remove the adjuster retainer clip, if installed, from the adjuster mounting tab.
- Insert the speed control actuator cable adjuster mounting tab in the slot provided in the accelerator cable support bracket.
- Pull cable through adjuster until a slight tension is felt without opening the throttle plate or increasing idle rpm.
- Insert adjuster retainer clip slowly until engagement is felt and then push downward until it locks in position.

### **Vacuum Dump Valve Adjustment**

Refer to Vacuum Dump Valve Test.

### REMOVAL AND INSTALLATION

#### **Control Switches**

#### Removal

- Remove the two retaining screws holding the horn pad assembly to the steering wheel.
- Lift the pad assembly to expose the horn and speed control wire terminals. Disconnect and remove the horn pad assembly.

NOTE: On F-B Series, care must be taken when removing wire terminal in steering wheel.
Compress clip firmly. Do not pull on wire or twist.

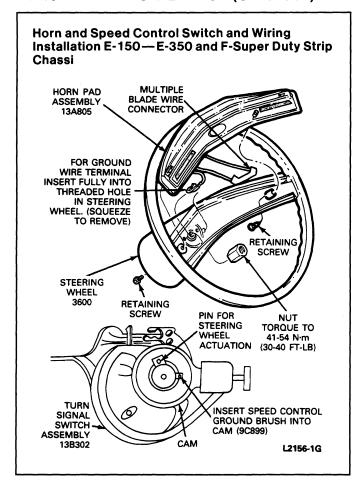
#### Installation

Attach the wires to the steering wheel hub and the horn pad assembly to the steering wheel with the two retaining screws.

NOTE: Do not replace individual switch of horn pad assembly.

CL4371-2B

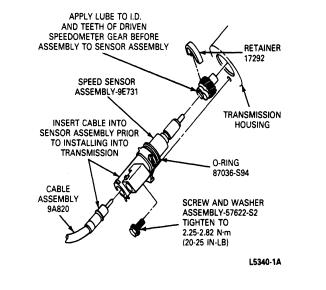
### **REMOVAL AND INSTALLATION (Continued)**



#### **Speed Sensor**

#### Removal

- Separate the electrical connector to speed sensor on the transmission.
- Disconnect speedometer cable from speed sensor.
- 3. Remove retaining bolt.
- 4. Remove the speed sensor.
- 5. Remove drive gear.



#### Installation

- Install drive gear on speed sensor. Refer to Section 13-02, Speedometer / Odometer.
- Install speed sensor in transmission.
- 3. Connect speedometer cable.
- 4. Connect the electrical connector.

#### **Amplifier Assembly**

### Removal

- 1. Disconnect the connectors at the amplifier.
- Remove the attaching screws or nuts that fasten the amplifier bracket to the vehicle.
- Remove the amplifier assembly and mounting bracket from the vehicle.
- Remove the amplifier assembly from the mounting bracket.

#### Installation

- 1. Install the amplifier on the mounting bracket.
- 2. Connect the connectors to the amplifier.
- Attach the amplifier assembly and mounting bracket to the vehicle with the attaching screws or nuts.
- Road test and check the system for proper operation.

# Servo Assembly (Throttle Actuator)

- Disconnect the wiring harness connectors under the hood at the servo assembly.
- Disconnect the adjuster from accelerator cable and disconnect the vacuum hose at the servo Y.

### **REMOVAL AND INSTALLATION (Continued)**

- Remove the screw attaching the actuator cable to the retaining bracket.
- Remove the pins and nuts retaining the servo assembly to the mounting bracket and remove the servo assembly.

#### Installation

- Position the servo assembly to the bracket and install the retaining nuts. Connect the vacuum hose.
- Attach the actuating cable to the retaining bracket.
- 3. Connect the adjuster to the accelerator cable.
- Connect the wiring harness connectors under the hood at the servo assembly.

#### **Actuator Cable**

For removal and installation refer to Servo Assembly. Remove the actuator cable from the servo assembly. Reverse the procedure for installation.

### **Vacuum Dump Valve**

#### Removal

- Remove the vacuum hose from the valve and remove the bracket mounting screw. On F-Series or Bronco vehicles the dump valve can be replaced without removing the bracket.
- 2. Remove the valve and bracket assembly.
- 3. Remove the valve from the bracket.

### Installation

- 1. Install the valve to the bracket.
- 2. Install the bracket mounting screw.
- Connect the vacuum hose.
- 4. Adjust dump valve.

# Vacuum Reservoir—7.3L Diesel Engine Removal

- Disconnect both vacuum hoses from the two ports located on the reservoir.
- Remove the two nuts retaining the reservoir from the underside of the LH apron and remove the reservoir.

#### Installation

- Position the reservoir to the LH apron. Secure with two nuts and tighten.
- 2. Connect the two vacuum hoses to the reservoir.

NOTE: Be certain when connecting the vacuum hoses that hoses are connected to the proper vacuum outlet at the reservoir.

### **Ground Brush**

#### Removal

- Remove the horn pad assembly and steering wheel for access. Refer to Section 11-04A, Steering Column-Shift Rod Within Tube.
- Snap the brush assembly out of the turn signal switch.

#### Installation

- Install the ground brush in the turn signal switch. (If the turn signal switch was lifted off the column when removing the ground brush, install the turn signal switch.)
- Install the steering wheel horn pad assembly and the steering wheel. Refer to Section 11-04A, Steering Column-Shift Rod Within Tube for steering wheel installation.

# Clutch Deactivator Switch (Manual Transmission Only)

- 1. Remove nut and bolt attaching switch to bracket.
- 2. Disconnect switch connector.
- 3. Reverse steps 1 and 2 for installation.

### SPECIAL SERVICE TOOLS

#### ROTUNDA EQUIPMENT

| Model     | Description           |
|-----------|-----------------------|
| 007-00013 | Speed Control Tester  |
| 007-00001 | Digital Volt-Ohmmeter |
| 021-00037 | Vacuum Pump           |

CL4691-1D



## INTRODUCTION

Most threaded fasteners are covered by specifications that define required mechanical properties, such as tensile strength, yield strength, proof load and hardness. These specifications are carefully considered in initial selection of fasteners for a given application. To assure continued satisfactory vehicle performance, replacement fasteners used should be of the correct strength, as well as the correct nominal diameter, thread pitch, length, and finish.

Most original equipment fasteners (English system or Metric) are identified with markings or numbers indicating the strength of the fastener. These markings are described in the pages that follow. Attention to these markings is important in assuring that the proper replacement fasteners are used.

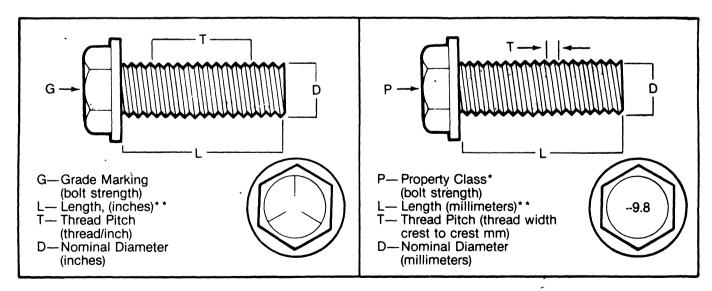
Further, some metric fasteners, especially nuts, are colored blue. This metric blue identification is in most cases a temporary aid for production start-up, and color will generally revert to normal black or bright after start-up.

English system and metric system fasteners are available through your Ford Parts and Service operation.

## **NOMENCLATURE FOR BOLTS**

(ENGLISH) INCH SYSTEM Bolt, 1/2-13x1

METRIC SYSTEM Bolt M12-1.75x25

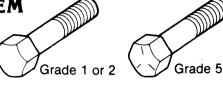


- \*The property class is an Arabic numeral distinguishable from the slash SAE English grade system.
- \*\*The length of all bolts is measured from the underside of the head to the end.



## **BOLT STRENGTH IDENTIFICATION**

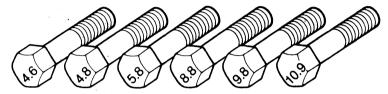
(ENGLISH) INCH SYSTEM





English (Inch) bolts—Identification marks correspond to bolt strength—increasing number of slashes represent increasing strength.

**METRIC SYSTEM** 



Metric bolts—Identification class numbers correspond to bolt strength—increasing numbers represent increasing strength. Common metric fastener bolt strength property are 9.8 and 10.9 with the class identification embossed on the bolt head.

# HEX NUT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM

**METRIC SYSTEM** 

Grade

Hex Nut Grade 5 Hex Nut Grade 8

Identification

Class

Hex Nut Property Class 9 Hex Nut Property Class 10

Identification



6 Dots

/

Arabic 9

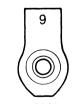
Arabic 10

Increasing dots represent increasing strength.

May also have blue finish or paint daub on hex flat. Increasing numbers represent increasing strength.

## OTHER TYPES OF PARTS

Metric identification schemes vary by type of part, most often a variation of that used of bolts and nuts. Note that many types of English and metric fasteners carry no special identification if they are otherwise unique.

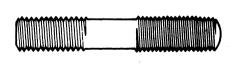


-Stamped U-Nuts



2 MET

 Tapping, thread forming and certain other case hardened screws









CLASS 10.9 CLASS 9.8 CLASS 8.8

 Studs, Large studs may carry the property class number. Smaller studs use a geometric code on the end.



# **ENGLISH METRIC CONVERSION**

| Description        | Multiply              | Ву                                     | For Metric Equivalent                       |
|--------------------|-----------------------|--|---|
| ACCELERATION       | Foot/sec <sup>2</sup> | 0.304 8                                | metre/sec² (m/s²)                           |
|                    | Inch/sec²             | 0.025 4                                | metre/sec²                                  |
| TORQUE             | Pound-inch            | 0.112 98                               | newton-metres (N·m)                         |
| •                  | Pound-foot            | 1.355 8                                | newton-metres                               |
| POWER              | horsepower            | 0.746                                  | kilowatts (kw)                              |
| PRESSURE or STRESS | inches of water       | 0.2488                                 | kilopascals (kPa)                           |
|                    | pounds/sq. in.        | 6.895                                  | kilopascals (kPa)                           |
|                    | pounds/sq. in.        | 1                                      | bar   |
| ENERGY or WORK     | BTU                   | 1 055.                                 | joules (J)                                  |
|                    | foot-pound            | 1.355 8                                | joules (J)                                  |
|                    | kilowatt-hour         | 3 600 000.<br>or 3.6 × 10 <sup>6</sup> | joules (J = one W's)                        |
| LIGHT              | foot candle           | 10.76                                  | lumens/metre² (lm/m²)                       |
| FUEL PERFORMANCE   | miles/gal             | 0.425 1                                | kilometres/litre (km/l)                     |
|                    | gal/mile              | 2.352 7                                | litres/kilometre (l/km)                     |
| VELOCITY           | miles/hour            | 1.609 3                                | kilometres/hr. (km/h)                       |
| LENGTH             | inch                  | 25.4                                   | millimetres (mm)                            |
|                    | foot                  | 0.304 8                                | metres (m)                                  |
|                    | yard                  | 0.914 4                                | metres (m)                                  |
|                    | mile                  | 1.609                                  | kilometres (km)                             |
| AREA               | inch²                 | 645.2                                  | millimetres² (mm²)                          |
| e.                 | · [                   | 6.45                                   | centimetres <sup>2</sup> (cm <sup>2</sup> ) |
|                    | foot <sup>2</sup>     | 0.092 9                                | metres² (m²)                                |
|                    | yard²                 | 0.836 1                                | metres²                                     |
| VOLUME             | inch³                 | 16 387.                                | mm³   |
|                    | inch <sup>3</sup> .   | 16.387                                 | cm³   |
|                    | inch <sup>3</sup>     | 0.016 4                                | litres (1)                                  |
|                    | quart                 | 0.946 4                                | litres                                      |
|                    | gallon                | 3.785 4                                | litres                                      |
|                    | yard³                 | 0.764 6                                | metres³ (m³)                                |
| MASS               | pound                 | 0.453 6                                | kilograms (kg)                              |
|                    | ton                   | 907.18                                 | kilograms (kg)                              |
|                    | ton                   | 0.90718                                | tonne                                       |
| FORCE              | kilogram              | 9.807                                  | newtons (N)                                 |
|                    | ounce                 | 0.278 0                                | newtons                                     |
|                    | pound                 | 4.448                                  | newtons                                     |
| TEMPERATURE        | degree farenheit      | 0.556 (°F -32)                         | degree Celsius (°C)                         |



# DECIMAL AND METRIC EQUIVALENTS

| Fractions | Decimal Inch | Metric mm |
|-----------|--------------|-----------|
| 1/64      | .015625      | .397      |
| 1/32      | .03125       | .794      |
| 3/64      | .046875      | 1.191     |
| 1/16      | .0625        | 1.588     |
| 5/64      | .078125      | 1.984     |
| 3/32      | .09375       | 2.381     |
| 7/64      | .109375      | 2.778     |
| 1/8       | .125         | 3.175     |
| 9/64      | .140625      | 3.572     |
| 5/32      | .15625       | 3.969     |
| 11/64     | .171875      | 4.366     |
| 3/16      | .1875        | 4.763     |
| 13/64     | .203125      | 5.159     |
| 7/32      | .21875       | 5.556     |
| 15/64     | .234375      | 5.953     |
| 1/4       | .250         | 6.35      |
| 17/64     | .265625      | 6.747     |
| 9/32      | .28125       | 7.144     |
| 19/64     | .296875      | 7.54      |
| 5/16      | .3125        | 7.938     |
| 21/64     | .328125      | 8.334     |
| 11/32     | .34375       | 8.731     |
| 23/64     | .359375      | 9.128     |
| 3/8       | .375         | 9.525     |
| 25/64     | .390625      | 9.922     |
| 13/32     | .40625       | 10.319    |
| 27/64     | .421875      | 10.716    |
| 7/16      | .4375        | 11.113    |
| 29/64     | .453125      | 11.509    |
| 15/32     | .46875       | 11.906    |
| 31/64     | .484375      | 12.303    |
| 1/2       | .500         | 12.7      |

| Fractions | Decimal Inch | Metric mm |
|-----------|--------------|-----------|
| 33/64     | .515625      | 13.097    |
| 17/32     | .53125       | 13.494    |
|           |              |           |
| 35/64     | .546875      | 13.891    |
| 9/16      | .5625        | 14.288    |
| 37/64     | .578125      | 14.684    |
| 19/32     | .59375       | 15.081    |
| 39/64     | .609375      | 15.478    |
| 5/8       | .625         | 15.875    |
| 41/64     | .640625      | 16.272    |
| 21/32     | .65625       | 16.669    |
| 43/64     | .671875      | 17.066    |
| 11/16     | .6875        | 17.463    |
| 45/64     | .703125      | 17.859    |
| 23/32     | .71875       | 18.256    |
| 47/64     | .734375      | 18.653    |
| 3/4       | .750         | 19.05     |
| 49/64     | .765625      | 19.447    |
| 25/32     | .78125       | 19.844    |
| 51/64     | .796875      | 20.241    |
| 13/16     | .8125        | 20.638    |
| 53/64     | .828125      | 21.034    |
| 27/32     | .84375       | 21.431    |
| 55/64     | .859375      | 21.828    |
| 7/8       | .875         | 22.225    |
| 57/64     | .890625      | 22.622    |
| 29/32     | .90625       | 23.019    |
| 59/64     | .921875      | 23.416    |
| 15/16     | .9375        | 23.813    |
| 61/64     | .953125      | 24.209    |
| 31/32     | .96875       | 24.606    |
| 63/64     | ,984375      | 25.003    |
| 1         | 1.00         | 25.4      |



## **TORQUE CONVERSION**

| POUND-FEET<br>(LB-FT) |
|-----------------------|
| 0.7376                |
| 1.5                   |
| 2.2                   |
| 3.0                   |
| 3.7                   |
| 4.4                   |
| 5.2                   |
| 5.9                   |
| 6.6                   |
| 7.4                   |
| 11.1                  |
| 14.8                  |
| 18.4                  |
| 22.1                  |
| 25.8                  |
| 29.5                  |
| 36.9                  |
| 44.3                  |
| 51.6                  |
| 59.0                  |
| 66.4                  |
| 73.8                  |
| 81.1                  |
| 88.5                  |
| 95.9                  |
| 103.3                 |
| 110.6                 |
| 118.0                 |
| 125.4                 |
| 132.8                 |
| 140.1                 |
| 147.5                 |
| 166.0                 |
| 184.4                 |
|                       |

| POUND-FEET<br>(LB-FT) | NEWTON METRES (N·m) |
|-----------------------|---------------------|
| 1                     | 1.356               |
| 2                     | 2.7                 |
| 3                     | 4.0                 |
| 4                     | 5.4                 |
| 5                     | 6.8                 |
| 6                     | 8.1                 |
| 7                     | 9.5                 |
| 8                     | 10.8                |
| 9                     | 12.2                |
| 10                    | 13.6                |
| 15                    | 20.3                |
| 20                    | 27.1                |
| 25                    | 33.9                |
| 30                    | 40.7                |
| 35                    | 47.5                |
| 40                    | 54.2                |
| 45                    | 61.0                |
| 50                    | 67.8                |
| 55                    | 74.6                |
| 60                    | 81.4                |
| 65                    | 88.1                |
| 70                    | 94.9                |
| 75                    | 101.7               |
| 80                    | 108.5               |
| 90                    | 122.0               |
| 100                   | 135.6               |
| 110                   | 149.1               |
| 120                   | 162.7               |
| 130                   | 176.3               |
| 140                   | 189.8               |
| 150                   | 203.4               |
| 160                   | 216.9               |
| 170                   | 230.5               |
| 180                   | 244.0               |

|   | Description and Operation                  |
|---|--|
|   | Coolant Flow                               |
| <b>A</b>                                    | Dual Mass Flywheel                         |
|   | (Manual Transmission Only) 03-01D-18       |
| Air Cleaners                                | Engine Components03-01D-10                 |
| Description                                 | Engine Description                         |
| Air Cleaner Diesel Engine03-12-1            | Fuel Flow                                  |
| Air Cleaner Gasoline Engines 03-12-1        | Glow Plug Fast Start System 03-01D-16      |
| Removal and Installation                    | Injection Nozzle Assemblies03-01D-16       |
| Air Cleaner Diesel Engine                   | Injection Pump                             |
| Air Cleaner Gasoline Engines                | Lubrication System03-01D-9                 |
| Alternator Belt                             | Vehicle and Engine Identification03-01D-18 |
|   | Diagnosis and Testing                      |
|   | Diagnosis Procedures —                     |
|   | Engine Components03-01D-21                 |
| B   | Maintenance                                |
|   | Accelerator Linkage                        |
|   | Engine Fuel Filter                         |
| Belt Tension                                | Engine Idle Speed                          |
|   | Engine Oil Level                           |
|   | Fuel Filter/Fuel Heater/Water              |
|   | Separator                                  |
| C   | Removal and Installation                   |
|   | Camshaft                                   |
|   | Camshaft Bearings03-01D-77                 |
| Cooling System — See Engine Cooling 03-03-1 | Camshaft Drive Gear, Fuel Pump Cam,        |
|   | Spacer and Thrust Plate03-01D-47           |
|   | Core Plugs03-01D-78                        |
|   | Crankcase Depression Regulator             |
| <b>D</b>                                    | (CDR)                                      |
|   | Crankshaft                                 |
|   | Crankshaft Drive Gear03-01D-44             |
| Diesel Engine — 7.3L V-803-01D-1            | Crankshaft Vibration Damper03-01D-37       |
| Adjustments03-01D-27                        | Cylinder Block                             |
| Cleaning and Installation                   | Cylinder Head                              |
| Camshaft                                    | Cylinder Heads                             |
| Connecting Rods                             | Engine Assembly                            |
| Crankcase Depression Regulator              | Engine Front Cover and Crankshaft          |
| (CDR)                                       | Oil Seal03-01D-39                          |
| Crankshaft                                  | Engine Front Insulators                    |
| Crankshaft Vibration Damper03-01D-91        | Engine Oil Cooler                          |
| Cylinder Block                              | Engine Oil Filter                          |
| Cylinder Heads                              | Engine Rear Insulator                      |
| Drive Gears                                 | Exhaust Manifolds                          |
| Exhaust Manifolds                           | Fitting Main or Connecting Rod Bearings    |
| Flywheel                                    | With Plastigage                            |
| Hydraulic Valve Tappets03-01D-90            | Flywheel Ring Gear                         |
| Intake Manifold                             | Flywheel, Engine Rear Cover and            |
| Main and Connecting Rod Bearing 03-01D-92   | Oil Seal                                   |
| Oil Cooler                                  | Front Crankshaft Oil Seal                  |
| Oil Pan                                     | Fuel Supply Pump                           |
| Oil Pump                                    | Injection Nozzle Fuel Lines03-01D-58       |
| Pistons, Pins and Rings03-01D-92            | Injection Nozzles                          |
| Push Rods                                   | Injection Pump                             |
| Thermostat                                  | Injection Pump Drive Gear and Drive Cover  |
| Valve Rocker Arm Assembly 03-01D-87         | Drive Cover                                |

#### Manually Tensioned Belts . . . . . . . . . . . . 03-05-13 D (Cont'd.) Engine — 4.9L (300 CID) Six-Cylinder ........ 03-01A Adjustments Intake Manifold, Valley Pan and Oil Pan, Oil Pump and Oil Pick-Up Description Crankcase Ventilation System . . . . . . . . . 03-01A-2 Piston and Connection Rod Assembly...03-01D-84 Emission Calibration Label . . . . . . . . . . . 03-01A-2 Pistons and Connecting Rods . . . . . . . . . 03-01D-73 Pistons, Pins and Rings ............ 03-01D-83 Exhaust Emission Control System ...... 03-01A-2 Repairing Engine Casting Holes and Disassembly and Assembly Cylinder Assembly . . . . . . . . . . . . . . . 03-01A-43 Valve Rocker Arm and Push Rod . . . . . . 03-01D-50 Valve Spring, Retainer and Stem Seal...03-01D-51 Piston and Connecting Rod . . . . . . . . . 03-01A-40 In-Vehicle Service Draining, Filling and Bleeding raining, Filling and Bleeding the Cooling System......03-03-1 Camshaft Rear Bearing Bore\_Plug . . . . . 03-01A-26 Connecting Rod Bearing.................03-01A-29 Crankcase Ventilation System ......... 03-01A-11 Engine Accessory Drive ......03-05 Adjustments Belt Tension — Alternator and Vacuum Pump Belton 7.3L Diesel Engine — Ambulance Models . . . . . . . . . . . . . . . . . . 03-05-11 Belt Tension Automatically Tensioned Belts......03-05-12 Belt Tension — Manually Tensioned Belts — F-Series and E-Series with 7.3L Diesel Pistons and Connecting Rods . . . . . . . . . 03-01A-29 Engine and 7.5L Gasoline Engine ...... 03-05-9 Power Steering Pulley Alignment.......03-05-12 Valve Rocker Arm Cover and Description Rocker Arm......03-01A-11 Accessory Drive Belts ......03-05-1 Valve Spring, Retainer and Stem Seal ... 03-01A-12 Fan and Clutch — Engine Operated . . . . . 03-05-2 Diagnosis and Testing Belt Tension — Automatically Removal and Installation Crankshaft Bearings.................03-01A-37 Belt Tension — Manually Tensioned Belts . . 03-05-7 Removal and Installation Automatic Belt Tensioner Pulley . . . . . . . . 03-05-14 Engines — 5.0L EFI (302 CID) V-8 and 5.8L EFI Automatically Tensioned Belts ..........03-05-13 Fan and Viscous Clutch — 4.9L EFI..... 03-05-15

Adjustments

Fan and Viscous Clutch — 5.0L, 5.8L and

| E (Cont'd.)  |             |
|--|-------------|
| Description  | ÷           |
| Crankcase Ventilation System                           |             |
| Engine   | 03-01B-1    |
| Exhaust Emission Control System                        |             |
| Diagnosis and Testing                                  | 03-01B-4    |
| Disassembly and Assembly                               |             |
| Cylinder Block Assembly — (6009)                       |             |
| Cylinder Block — (6010)                                |             |
| Cylinder Heads   |             |
| Engine   |             |
| Oil Pump   |             |
| Pistons and Connecting Rods                            |             |
| Tappet   | 03-01B-53   |
| III-AGUICIE OGLAICE                                    | 00 04D 00   |
| Campbett Boor Booring Boro Blug                        |             |
| Camshaft Rear Bearing Bore Plug                        |             |
| Clutch Pilot Bearing                                   |             |
| Connecting Rod Bearings                                |             |
| Crankcase Ventilation System  Crankshaft Rear Oil Seal |             |
| Cylinder Front Cover and Timing                        | 03-015-30   |
| Chain  | 03-01B-28   |
| Cylinder Heads   |             |
| Electronic Fuel Injection                              |             |
| Engine Components                                      |             |
| Engine Front Supports                                  |             |
| Engine Rear Supports                                   |             |
| Exhaust Manifolds                                      |             |
| Flywheel   |             |
| Front Oil Seal   |             |
| Intake Manifold  | . 03-01B-23 |
| Main Bearing   | . 03-01B-36 |
| Oil Filter   | . 03-01B-40 |
| Oil Pan  | 03-01B-18   |
| Oil Pump   |             |
| Pistons and Connecting Rods                            |             |
| Tappet   | 03-01B-25   |
| Valve Rocker Arm Cover and                             |             |
| Rocker Arm   |             |
| Valve Spring, Retainer and Stem Seal.                  |             |
| Water Pump   | 03-01B-27   |
| Removal and Installation                               | 00.045.40   |
| Camshaft Bearings                                      |             |
| Crankshaft   |             |
| Engine Assembly  |             |
| Special Servcie Tools                                  |             |
| Specifications   |             |
| Vehicle Application                                    |             |
| ngine Cooling  |             |
| Cleaning and inspection  Cleaning Cooling System       | 03-03-10    |
| Heater Core Back-Flushing                              |             |
| Tioator Coro Daon Flaorining                           |             |

| Radiator Coolant Level Check                       |           |
|--|-----------|
| Radiator Pressure Cap                              | 03-03-13  |
| Description  | 20.00.4   |
| Coolant Recovery System                            |           |
| Radiator   | 03-03-2   |
| Diagnosis and Testing                              | 02.02.5   |
| Cooling System Pressure Test  Diagnosis Guides     |           |
| Leak Test  |           |
| Radiator Cap Pressure Test                         |           |
| Thermostat Test                                    |           |
| Operation  |           |
| Draining, Filling and Bleeding the                 |           |
| Cooling System                                     | 03-03-5   |
| Removal and Installation                           |           |
| Coolant Recovery Bottle                            | 03-03-14  |
| Radiator and Fan Shroud                            | 03-03-15  |
| Thermostat   | 03-03-13  |
| Service Procedures                                 |           |
| Aluminum Crossflow Radiators                       |           |
| Copper/Brass Radiators                             |           |
| Radiator Core Service                              |           |
| Threaded Radiator Draincock                        |           |
| Specifications                                     |           |
| Engine — 7.5L (460 CID) EFI V-8                    | 03-01C    |
| Adjustments  | 00.040.0  |
| Valve Clearance                                    | 03-010-3  |
| Description  | 20.040.0  |
| Cooling System                                     |           |
| Crankcase Ventilation System                       |           |
| Emission Calibration Label                         |           |
| Engine   |           |
| Exhaust Emission Control System Lubrication System |           |
| Diagnosis and Testing                              |           |
| Disassembly and Assembly                           | 03-010-3  |
|  | 03-01C-43 |
| Cylinder Assembly                                  | 03-010-43 |
| Cylinder Head                                      |           |
| Piston and Connecting Rod                          |           |
| Valve Tappet                                       | 03-01C-40 |
| In-Vehicle Service                                 |           |
| Camshaft   | 03-01C-22 |
| Camshaft Rear Bearing Bore Plug                    |           |
| Clutch Pilot Bearing                               |           |
| Connecting Rod Bearing                             |           |
| Crankcase Ventilation System                       |           |
| Crankshaft Rear Oil Seal                           |           |
| Cylinder Heads                                     |           |
| Electronic Fuel Injection                          |           |
| Engine Components                                  |           |
| Engine Front Supports                              |           |
| Engine Rear Support                                | 03-01C-5  |
| Exhaust Manifolds                                  |           |
| Flywheel   |           |
| Front Cover and Timing Chain                       | 03-01C-18 |
|  |           |

## E (Cont'd.) Pistons and Connecting Rods . . . . . . . . 03-01C-26 Valve Rocker Arm and Hydraulic Lash Adjuster......03-01C-10 Valve Spring, Retainer and Stem Seal ... 03-01C-11 Removal and Installation Engine — E-250 — E-350 . . . . . . . . . . 03-01C-29 Engine — F-250 — F-350 — F-Super **Duty Chassis Cab and Motor Home** Chassis......03-01C-32 Description Exhaust Emission Control System........03-00-2 Diagnosis and Testing Excessive Engine Oil Consumption......03-00-5 Fluorescent Oil Additive Method . . . . . . . . 03-00-3 Flywheel Runout (Manual Transmission) ... 03-00-9 Positive Closed-Type Crankcase Ventilation Static Engine Off Valve Train Analysis . . . . . 03-00-6 Overhaul Cylinder Walls, Refinishing . . . . . . . . . . 03-00-10 Exhaust Manifold ......03-00-24 Fitting Main or Connecting Rod Bearings with Plastigage......03-00-13

| Flywheel Service Repair: Re-Machine |           |
|-------------------------------------|-----------|
| Clutch Surface                      | 03-00-25  |
| Hydraulic Tappets                   | 03-00-18  |
| Inspection                          |           |
| Intake Manifold                     | 03-00-24  |
| Main and Connecting Rod Bearings    | 03-00-13  |
| Oil Pan                             |           |
| Oil Pump                            | 03-00-19  |
| Pistons, Pins and Rings             |           |
| Push Rods                           |           |
| Service Limit Specifications        | . 03-00-9 |
| Valve Rocker Arm                    |           |
| Special Service Tools               | 03-00-25  |
| Vehicle Application                 |           |
| Engine-Diesel — See Diesel Engine   |           |
| •                                   |           |

## F

| Fan and Clutch                           |         |
|--|---------|
| Fan Belts                                |         |
| Fuel Injection — 4.9L EFI Engine 0       | 3-04B-1 |
| Cleaning and Inspection                  |         |
| Air Bypass Valve 0                       | 3-04B-5 |
| Components                               |         |
| Fuel Injectors 0                         | 3-04B-4 |
| Fuel Pressure Regulator 0                | 3-04B-4 |
| Fuel Supply Manifold Assembly 0          | 3-04B-5 |
| Throttle Body Assembly 0                 | 3-04B-4 |
| Description                              | 3-04B-1 |
| Operation                                |         |
| Air Intake Manifold 0                    | 3-04B-3 |
| Removal and Installation                 |         |
| Air Bypass Valve Assembly 03             | -04B-18 |
| Air Intake Throttle Body                 | -04B-16 |
|  | -04B-13 |
| Fuel Charging Assembly 0                 | 3-04B-6 |
|  | -04B-22 |
| Fuel Injector 03                         | -04B-23 |
| Fuel Pressure Regulator 03               | -04B-21 |
| Fuel Supply Manifold Assembly 03         |         |
|  | -04B-22 |
| Throttle Position Sensor 03              | -04B-18 |
| Upper Intake Manifold and Throttle       |         |
| Body Assembly 03                         | -04B-13 |
| Fuel Injection — 5.0L and 5.8L Engines 0 | 3-04A-1 |
| Cleaning and Inspection                  |         |
| Air Bypass Valve 0                       | 3-04A-5 |
| Components                               |         |
| Fuel Injectors 0                         | 3-04A-3 |
| Fuel Pressure Regulator                  | 03-04-4 |
| Fuel Supply Manifold Assembly 0          |         |
| Throttle Body Assembly 0                 |         |
| Description and Operation 0              | 3-04A-1 |
| •  |         |

# F (Cont'd.)

| Operation                                |             |
|--|-------------|
| Air Intake Manifold                      | . 03-04A-2  |
| Removal and Installation                 |             |
| Air Bypass Valve Assembly                | 03-04A-12   |
| Air Intake Throttle Body                 |             |
| Fuel Charging Assembly                   |             |
| Fuel Injector                            |             |
| Fuel Pressure Regulator                  |             |
| Fuel Supply Manifold Assembly            |             |
| •  | 03-04A-13   |
| Fuel Tank, Pump, Lines and Filters —     |             |
| Gasoline Engines                         | 10-01A      |
| Description                              |             |
| Canister Purge Control Valve             |             |
| (Non-Electrical Control)                 |             |
| Canister Purge Solenoid (Canister Purge  |             |
| Regulator Valve)                         | . 10-01A-12 |
| Carbon Canister                          |             |
| Electronic Fuel Injection (EFI)          |             |
| F-Series and Bronco Fuel Pump —          |             |
| Electric (FDM)                           | 10-014-2    |
| Fill Control/Vent                        |             |
| Fuel Delivery Module (FDM) — F-Series    | . 10-01A-13 |
|  | 10 01 4 5   |
| and Bronco                               | 10-01A-5    |
| Fuel Delivery Module (FDM) — F-Series    |             |
| and Bronco                               |             |
| Fuel Evaporative Emission System         |             |
| Fuel Filters — Gasoline Engines          |             |
| Fuel Lines                               |             |
| Fuel Pump Control — Econoline            |             |
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